U.S. DEPARTMENT OF COMMERCE
National Technical Information Service
PB80-113467

Sewage Effluent Disposal for the City of Bend, Oregon

Jones and Stokes Associates, Inc, Sacramento

Prepared for

Environmental Protection Agency, Seattle, WA Region X

1979

PB80-113467

EPA

Sewage Effluent Disposal For The City of Bend, Oregon

REPRODUCED BY
NATIONAL TECHNICAL
INFORMATION SERVICE
U. S. DEPARTMENT OF COMMERCE
SPRINGFIELD, VA. 22161

TECHNICAL REPORT DATA

(Please read Instructions on the reverse before completing)

1. REPORT NO. EPA 910/9-79-063

2.

3. RECIPIENT'S ACCESSION NO. PB80-113467

4. TITLE AND SUBTITLE
SEWAGE EFFLUENT DISPOSAL FOR THE CITY OF BEND, OREGON

5. REPORT DATE [illegible] 1979

6. PERFORMING ORGANIZATION CODE

7. AUTHOR(S)

8. PERFORMING ORGANIZATION REPORT NO.

9. PERFORMING ORGANIZATION NAME AND ADDRESS
Jones & Stokes Associates, Inc.
2321 P Street
Sacramento, CA 95816

10. PROGRAM ELEMENT NO.

11. CONTRACT/GRANT NO.

12. SPONSORING AGENCY NAME AND ADDRESS
U.S. Environmental Protection Agency
Region X
1200 Sixth Avenue, Seattle, WA 98101

13. TYPE OF REPORT AND PERIOD COVERED EIS

14. SPONSORING AGENCY CODE

15. SUPPLEMENTARY NOTES

16. ABSTRACT

The City of Bend, Oregon has proposed to construct a new 6 million gallons per day (mgd) secondary treatment plant to replace the present facility which treats an average of 0.5 mgd. The majority of domestic wastes are currently disposed of through septic tanks discharging to lava sink holes or drill holes. These waste disposal wells have been declared a potential public health hazard because they create a potential for contamination of domestic water supply wells which are numerous in the area.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
Sewage Treatment Plants Ground water Bend, Oregon	Bend, Oregon	

18. DISTRIBUTION STATEMENT
unlimited distribution

19. SECURITY CLASS *(This Report)* unclassified

20. SECURITY CLASS *(This page)* unclassified

21. NO. OF PAGES 162

22. PRICE A08/A01

EPA Form 2220-1 (9-73)

SEWAGE EFFLUENT DISPOSAL FOR THE CITY OF BEND, OREGON

Prepared By:

Jones & Stokes Associates, Inc.
2321 P Street
Sacramento, CA 95816

In Association With:

Culp, Wesner and Culp

TABLE OF CONTENTS

Page

SUMMARY 1

CHAPTER 1 - INTRODUCTION 7
  Background of Past Events 7
  Effluent Disposal Alternatives 10
  Problem Description/Issues 10
  Necessity/Purpose of EIS 10

CHAPTER 2 - AFFECTED ENVIRONMENT 13
  Introduction 13
  Location 13
  Climate 13
  Land Resources 13
    Topography 13
    Geology 15
    Soils 15
    Land Use 16
  Water Resources 16
    Surface Water Quality/Quantity 16
    Groundwater Quality/Quantity 17
    Water Supply and Beneficial Uses 18
    Flood Hazards 18
  Air Quality 18
  Biological Resources 19
    Flora 19
    Fauna 19
    Rare and Endangered or Threatened Species 20
  Archeological and Historical Resources 20
  Aesthetics 20
  Social Environment 21

CHAPTER 3 - WASTEWATER CONVEYANCE, TREATMENT AND DISPOSAL SYSTEMS

  Introduction 23
  Historical Wastewater Handling Systems 23
  Existing Wastewater Handling Systems 25
  Future Wastewater Handling Systems 28
    The Stevens, Thompson & Runyan Engineers Facilities Plan (STR) 28
    The Modified Facilities Plan (BECON) 30

Page

CHAPTER 4 - ALTERNATIVE EFFLUENT DISPOSAL AND REUSE SYSTEMS 39
- Introduction 39
- Screening of Effluent Disposal and Reuse Alternatives 39
  - STR Proposed Alternatives 40
- Proposed Effluent Disposal and Reuse Alternatives 42
  - Subsurface Disposal 42
  - Discharge to the Deschutes River 44
  - Discharge to Sealed Evapotranspiration Ponds 44
  - Land Application by Spray Irrigation 47
  - Discharge to the North Unit Main Canal 50
- No-Action Alternative 51

CHAPTER 5 - LEGAL, POLICY AND INSTITUTIONAL CONSTRAINTS 53
- Environmental Requirements (General) 53
- Cultural Resources and Land Use Constraints 54
- Water Pollution Control 56
- Water Quality Standards and Effluent Disposal 59

CHAPTER 6 - EFFECTS OF THE ALTERNATIVES ON ENVIRONMENTAL RESOURCES 63
- Introduction 63
- Short-Term Impacts 63
- Primary and Secondary Long-Term Impacts 67
  - Reliability 68
  - Groundwater 69
  - Surface Waters - Deschutes River 82
  - Surface Waters - North Unit Main Canal System 85
  - Public Health 89
  - Fisheries 99
  - Wildlife 101
  - Vegetation and Soils 101
  - Land Use 102
  - Odors 102
  - Noise 102
  - Aesthetics 103
  - Archeology/History 103
  - Resource Consumption 105
  - Monetary Costs 105
  - Mitigation Measures 114

Page

Local Short-Term Uses of the Environment vs. Maintenance and Enhancement of Long-Term Productivity 118
Irreversible and Irretrievable Commitment of Resources 119
Unresolved Issues 119

CHAPTER 7 - LIST OF PREPARERS 121

CHAPTER 8 - BIBLIOGRAPHY 123

CHAPTER 9 - APPENDICES 129

LIST OF FIGURES

Figure		Page
2-1	Study Area	14
3-1	Diagram of a Typical Domestic Sewage Disposal System in the Bend Area	24
3-2	Existing Sewerage Systems	26
3-3	Lava Tube Effluent Disposal From the Existing Wastewater Treatment Plant	27
3-4	A Sample of Water Wells in the Bend Area	29
3-5	Treatment Plant Locations and Proposed Effluent Disposal Areas (Sites C & E)	31
3-6	Schematic Diagram of Proposed Treatment Plant	33
3-7	Preliminary Plant Layout	34
3-8	Projected Annual Average Wastewater Flows	35
4-1	Potential Location of Infiltration Pond and Gravity Pipeline	45
4-2	Proposed Effluent Disposal Outfall to the Deschutes River	46
4-3	Potential Location of Pipeline/Canal Route and Ponded Areas	48
4-4	Potential Sites for Land Application by Spray Irrigation	49
6-1	Idealized Plume of Effluent from Site E	74
6-2	Flow in a Water-Table Aquifer	76
6-3	Potential Mechanism for Contamination of Uncased Well	77
6-4	Locations of Domestic Water Diversions and Recreational Use on the Deschutes River Below Bend	84
6-5	The North Unit Irrigation District Canal and Reservoir System	86
6-6	Historical Roads in the Project Area	104
6-7	Primary Energy Use	106
6-8	Estimated Secondary Energy Requirements	107
6-9	Estimated Present Worth Values	108
6-10	User Charge Per Home	110

LIST OF TABLES

Table		Page
3-1	Monthly Wastewater Volumes and Average Daily Flows (Based on a 6 MGD Annual Average Daily Flow)	36
3-2	Summary of Effluent Quality (City of Bend Wastewater Treatment Plant)	38
4-1	Anticipated Effluent Quality for Each Major Alternative	43
6-1	Short-Term Impacts Bend Effluent Disposal Alternatives	64
6-2	Morphometric Data for Haystack Reservoir	87
6-3	Removal of Coliforms by Sedimentation in Saturated Sand of Various Effective Sizes	91
6-4	Soil Texture and Coliform Count at a Depth of 3 Feet For Five Soils Upon Which Sewage Was Spread	97
6-5	Projected 1979 Use and Costs of Aquatic Herbicides - North Unit Irrigation District	112

SUMMARY

Background

Adequate sewage treatment in the City of Bend, Oregon is provided for approximately 10 percent of the city's population by the city secondary wastewater treatment plant. Disinfection effluent produced by the plant is discharged into a lava sink hole on the plant site. At present the treatment plant treats an average sewage flow of 0.5 million gallons per day (mgd).

The majority of domestic wastes, however, are disposed of through septic tanks discharging to lava sink holes or drill holes. Approximately 6,000 to 7,000 of these waste disposal wells are currently utilized in the Bend area.

These waste disposal wells have been declared a potential public health hazard by the Oregon State Department of Environmental Quality (DEQ) because they create a potential for contamination of domestic water supply wells, which are also numerous in the Bend area. Subsequent DEQ regulations prohibiting construction and use of waste disposal wells after 1980 prompted the city to study alternative methods of treating domestic wastes.

As a result of these studies, the city proposed to construct a new 6 mgd secondary wastewater treatment plant at a new location approximately 4 miles northeast of the city. The existing treatment plant would be abandoned due to a potential for significant adverse environmental impacts associated with its expansion. Effluent produced by the new treatment plant would be discharged to the subsurface on an interim basis with a final method of effluent disposal to be determined at a later date.

In 1978, the Environmental Protection Agency (EPA) issued a Negative Declaration for design and construction of the new treatment plant, which is currently under construction. The EPA, however, decided to prepare an Environmental Impact Statement (EIS) on the ultimate method of effluent disposal because of the potential for adverse environmental impacts associated with the proposed interim method of effluent disposal.

Effluent Disposal Alternatives

Five major alternatives of effluent disposal from the new wastewater treatment plant are described and evaluated in this document. These are: 1) subsurface disposal via drill holes or infiltration ponds near the treatment plant; 2) discharge to the Deschutes River below the Bend diversion dam; 3) discharge to evapotranspiration ponds (i.e., sealed ponds developed as wildlife habitat) extending in a northeast direction from the treatment plant; 4) land application by spray irrigation of a harvestable grass crop; and 5) discharge to the North Unit Main Canal, which includes modifications to year-round canal discharge to avoid discharging effluent to an empty canal. The "No-Action" alternative, which would be a continuation of existing wastewater treatment and disposal methods (i.e., secondarily treated, disinfected effluent discharged to a lava sink hole and inadequately-treated wastes discharged to disposal wells) is also evaluated.

Effluent treatment processes would vary under the proposed alternatives. Advanced wastewater treatment employing sand filters for bacteria and virus removal would be used for effluent discharge to the subsurface via drill holes, the Deschutes River and the North Unit Main Canal. Effluent quality would be less stringent for discharge to infiltration ponds, evapotranspiration ponds and land irrigation systems, which would utilize natural filtration processes to purify the effluent.

Environmental Effects of the Alternatives and Mitigation of Adverse Impacts

Short-term construction-related impacts of varying magnitudes would occur with all alternatives except the no-action alternative. These impacts would include temporary loss of vegetation, disruption of wildlife, dust and aerial pollutants, soil erosion, noise, visual impacts, traffic congestion, safety hazards and water quality impairment.

Long-term impacts of the major alternatives are summarized in Table A. Major adverse impacts associated with particular alternatives are described below.

The major adverse impact associated with subsurface disposal to drill holes would be the potential for groundwater contamination, which could adversely affect domestic well water use and pose a threat to public health.

Table A

SUMMARY OF LONG-TERM IMPACTS - MAJOR ALTERNATIVES

	Major Alternatives[1]						
	Subsurface						
Environmental Element	Drill Holes	Infiltration Ponds	Deschutes River	Evapo-transpiration Ponds	Land Application by Spray Irrigation	North Unit Main Canal	No Action
Potential Adverse Impacts:							
Surface water quality	-	-	+	-	-	+	-
Groundwater	+	0	-	-	0	0	+
Public Health	+	0	+	0	0	+	+
Fisheries	-	-	+	-	-	+	-
Wildlife	-	0	-	+	+	-	-
Vegetation and soils	-	0	-	+	+	-	-
Land use	-	0	-	0	+	-	-
Odors	-	0	-	0	0	-	+
Noise	-	-	0	-	0	-	+
Aesthetics	-	-	+	-	0	+	+
Archeology/history	-	0	-	+	+	-	-
Resource consumption	0	0	+	0	+	0	-
User costs	0	0	+	+	+	0	-
Other direct costs	-	-	-	-	-	+	-
Ability to expand	-	0	-	+	+	-	+
Potential Beneficial Impacts:							
Wildlife	-	0	-	+	0	-	-
Vegetation and soils	-	-	-	-	+	-	-
Aesthetics	-	-	-	+	-	-	-

1 + Significant impact
0 Moderate impact
- Negligible or no impact

Establishment of an extensive groundwater monitoring program prior to any subsurface disposal of effluent is suggested as a mitigation measure to aid in estimating groundwater conditions below the disposal site and attenuation of pollutants once they enter the ground. In the event of domestic well contamination, new wells could be drilled to the deep artesian aquifer.

Major adverse impacts of subsurface disposal via infiltration ponds would be a significant land commitment, potential vector problems and a reduced potential for groundwater contamination. Potential mitigation measures include use of insecticides to control mosquitos, proper maintenance of infiltration ponds to prevent clogging of the filtering medium and a small-scale monitoring program to detect groundwater contamination below the site.

Major impacts of effluent discharge to the Deschutes River would be adverse effects, particularly in summer, on water quality and fisheries resources. Downstream domestic water use might be precluded as a safeguard to public health. Potential mitigation measures include upgrading the treatment process to reduce water quality degradation and the potential for ammonia and chlorine toxicity to aquatic life and developing alternative sources of drinking water for domestic users downstream.

Major adverse impacts associated with development of evapotranspiration ponds would be a large land commitment, loss of native wildlife habitat, a public health risk from insect vectors or effluent contact, a high initial capital expenditure and high user costs. Wildlife habitat losses should be mitigated by creation of new aquatic habitat that would benefit native species in surrounding habitat as well as attract new species to the area. Insect vectors could be controlled using insecticides or through natural means. To protect against diseases, contact with undiluted, unpurified effluent in the first ponds of the series could be prevented by fencing. Public education programs would be beneficial.

Major impacts associated with land application by spray irrigation include a high initial capital expenditure, high operation and maintenance costs, a large land commitment, reduced ability to accommodate future expansion and a significant loss of vegetation and associated wildlife. Wildlife habitat losses could be slightly mitigated by enhancing adjacent native habitat.

Major adverse impacts of discharge to the North Unit Main Canal include public health risks to domestic water users in the City of Madras, accelerated eutrophication of the canal system and Haystack Reservoir, impacts of the reservoir fisheries increased costs to the North Unit Irrigation District for control of increased aquatic weed growth and for liability insurance and potential groundwater contamination from seepage in winter. As a mitigation measure, an alternative source of domestic water could be developed for the City of Madras. Nutrient removal by advanced wastewater treatment would reduce the potential for accelerated eutrophication and adverse impacts on the fishery. Increased costs of aquatic weed control could be mitigated by improving effluent treatment through nutrient removal or by reimbursing the District for estimated increased expenditures. The City of Bend could assume liability for public health risks to irrigators and recreationists. A small-scale monitoring program could be developed to detect any groundwater contamination from canal seepage in winter. Modifications to year-round canal disposal, which would eliminate adverse impacts of winter discharge, are indicated.

The no-action alternative would allow for continued disposal of inadequately-treated septic tank wastes once the capacity of the existing treatment plant was exceeded. The major adverse impact associated with this alternative would be the possibility of groundwater contamination and related public health risk from contaminated domestic well water. As the population in the Bend area increases, the potential for groundwater contamination would also increase. Complaints related to odors, noise and heavy truck traffic would increase as residential developments grow around the existing treatment plant.

Chapter 1

INTRODUCTION

Background of Past Events

In 1970 the City of Bend population was 13,710 while the urban area population was 19,150. By 1974 the estimated city and urban population had grown to 17,215 and 25,690, respectively. The year 2000 population for the urban area is projected to be 60,000. Presently, about 10 percent is being served by sewers and adequate sewage treatment.

In 1970 the City of Bend constructed a sewage collection and treatment plant designed to serve a population of 20,000, which would produce an average sewage flow of about 2 million gallons per day (mgd). The facility provides secondary treatment (actived sludge process) and discharges disinfected effluent into a lava sink hole on the plant site. The plant presently treats an average sewage flow of 0.5 mgd.

Five other wastewater treatment and disposal facilities are operated in the study area. They are small units serving apartment complexes and industries, and most are approved for interim use until a regional sewage system becomes available.

The majority of domestic wastes are disposed of through septic tanks discharging to lava sink holes or drill holes. Approximately 6,000 to 7,000 of these waste disposal wells are currently utilized in the Bend area. This method of disposal is necessary because the soil overburden is generally less than 12 inches deep, which does not provide sufficient surface leaching.

Although no evidence has been documented to date, these several thousand waste disposal wells create a potential for contamination of domestic well water supplies, and thus are a public health hazard. A study done by the Federal Water Quality Administration entitled *Liquid Waste Disposal in Lava Terrane of Central Oregon* concluded that a continued discharge of septic tank wastes to drill holes poses a potential hazard to the quality of the groundwater (Sceva, 1968). Subsequently, the Oregon Department of Environmental Quality (DEQ) promulgated regulations prohibiting the construction of additional lava sink holes for disposal of inadequately treated wastes in the Bend urban area after January 1975 and prohibiting their use beyond January 1980.

As a result of these regulations and a formal requirement issued to the city by DEQ on September 5, 1975 as part of the waste discharge permit, the City of Bend initiated a study to determine the proper treatment and disposal of sanitary wastes for the Bend urban area. A report entitled Sewerage Facilities Plan, City of Bend, Oregon was prepared for the city in September 1976 by Stevens, Thompson & Runyan, Inc. and Tenneson Engineering Corporation. In this document the recommended plan called for expansion of the existing wastewater treatment facility to a capacity of 6.0 mgd. Approximately 150,000 linear feet of collector and interceptor sewers would be installed and disposal of treated effluent would be through year-round spray irrigation on approximately 600 acres located about 3 miles north of the treatment plant.

After environmental review of this document, the U. S. Environmental Protection Agency (EPA) determined that the proposed project did not constitute a significant action and therefore did not require an Environmental Impact Statement (EIS). On April 5, 1977, the EPA released a Negative Declaration announcing its preliminary decision not to prepare an EIS. This decision was based on the fact that the proposed project conformed with the city's local land use plan and with statewide planning goals and guidelines. The city's proposed project to sewer the entire City of Bend would also be necessary to comply with state water quality regulations.

On July 8, 1977 upon completion of the 15-day comment period on the Negative Declaration, the EPA awarded a Step II construction grant to the City of Bend for design of the proposed project. After reevaluation of the proposed project, however, the city decided to reject the plan approved by EPA and instead proposed to construct a new secondary wastewater treatment plant at a site on Bureau of Land Management (BLM) land approximately 4 miles northeast of the existing facility. The effluent would be filtered, disinfected and discharged year-round to the subsurface via drill holes or lava tubes or cracks on the new site as an interim measure with a permanent disposal method to be proposed at a later date. The existing treatment plant and disposal site would be abandoned.

The city proposed this alternative to the EPA in Amendment Number One to the Sewerage Facilities Plan in November 1977, contending that a comparative cost analysis of the treatment alternatives showed the total cost was essentially the same for either alternative. The city also contended that major environmental impacts would occur if the existing plant was expanded. Among these nuisance impacts were noise and odor problems relating to recent residential developments around the existing facility.

To review costs associated with the two treatment plants and relocation to the new site, the EPA contracted Brown and Caldwell Engineers to perform an independent cost comparison analysis. The Brown and Caldwell analysis reported that construction of the new plant would be as cost-effective as expansion of the existing plant. As a result, on April 5, 1978 the EPA issued a Negative Declaration for design and construction of the new wastewater treatment plant, and collector and interceptor sewers. However, because the city's newly proposed project contained significant changes in the method of effluent disposal, the EPA determined to prepare an EIS on the ultimate means of effluent disposal.

In the event that the EPA has not selected a final effluent disposal alternative when the new treatment plant is ready for start-up (estimated August 1980), the City of Bend has approval from the DEQ for use of subsurface disposal, defined as a drill hole, as an interim method of effluent disposal. Interim use of a drill hole was conditionally approved by the EPA in a letter to the DEQ dated March 16, 1978.

Conditions that must be met before EPA can give final interim approval to subsurface effluent disposal to a drill hole are:

1. Disposal to a drill hole must be the only feasible alternative available at the time of actual use.
2. The City of Bend must pursue and exhaust other available interim or final disposal alternatives.
3. Discharge to a drill hole must be found to be environmentally acceptable in this EIS.
4. The City of Bend must commit itself to aggressively constructing the final disposal system to limit the use, if any, of an interim solution.
5. A comprehensive groundwater monitoring program approved by EPA must be established and operable prior to the time of first discharge. This monitoring program is intended to evaluate the fate and impact of effluent on the receiving groundwater aquifers, including the regional groundwater table.

More recently, in Design Definition Memorandum #10 (June 1979), BECON has redefined subsurface disposal to include gravity flow to drill holes, gravity flow to a lava crack (or tube), areal percolation (through natural percolation or induced by blasting to fracture lava strata) or pumped flow to injection wells.

Effluent Disposal Alternatives

The major effluent disposal alternatives evaluated in this EIS are: 1) subsurface disposal via drill holes or infiltration, 2) discharge to the Deschutes River, 3) discharge to the North Unit Main Canal, 4) land application by spray irrigation, and 5) discharge to a series of sealed ponds developed as wildlife habitat. The no-action alternative, which would be continuation of the present methods of effluent disposal (discharge of secondarily-treated effluent to a lava tube from the existing wastewater treatment plant and subsurface disposal of inadequately-treated wastes from individual septic tanks) is also evaluated.

Problem Description/Issues

It is clear that there are several key environmental and economic issues relating to the proposed, alternative methods of effluent disposal. These issues became evident through discussions with City of Bend officials, personnel of various local, state and federal agencies and review of relevant correspondence and reports.

The issues listed below are identified and evaluated more fully in Chapter 6 - EFFECTS OF THE ALTERNATIVES ON ENVIRONMENTAL RESOURCES. Those issues remaining unresolved and/or of greater scope than covered in this EIS will also be discussed in Chapter 6. The generic issues of particular importance to this project are:

- The impacts on the quality and domestic use of the groundwater system resulting from subsurface disposal or infiltration of treated effluent.
- The biological, social and economic impacts of effluent discharge to the Deschutes River or the North Unit Main Canal.
- The monetary and land use cost of installation and operation of a spray-irrigation system for year-round effluent disposal.

Necessity/Purpose of EIS

The National Environmental Policy Act of 1969 (NEPA) requires that all agencies of the federal government prepare a detailed EIS on proposals for projects that may significantly affect the quality of the human environment. NEPA requires that agencies (in this case EPA) include in their decision-making process all considerations of environmental aspects of proposed actions, the environmental impacts of the proposed project and its alternatives, and a discussion of ways to avoid or minimize adverse effects. The EIS is to be a "full disclosure" document and must follow specific regulations of the EPA contained in 40 CFS, part 6, as published in the Federal Register, Vol. 40, No. 72, April 14, 1975.

Because the City of Bend project can be 75 percent funded by the EPA, as part of the Construction Grants Program authorized by the Federal Water Pollution Control Act Amendments of 1972 (PL 92-500), it requires NEPA action. After reviewing the amended Step II grant application from the City of Bend for the design of a new wastewater treatment facility, the EPA determined that significant environmental impacts may be associated with effluent disposal and therefore an EIS was required for the ultimate method of effluent disposal. This decision was based on the potential of the present and proposed means of effluent disposal to cause significant adverse impacts on the quality of groundwater in the Bend area.

Chapter 2

AFFECTED ENVIRONMENT

Introduction

This chapter presents a brief description of the project area environment for reader orientation. More detailed information regarding the environment directly affected by project alternatives is given in Chapter 6 (EFFECTS OF THE ALTERNATIVES ON ENVIRONMENTAL RESOURCES).

Location

The study area, extending from the City of Bend and its surrounding urban area north to the Madras area, is located in Deschutes and Jefferson Counties in west-central Oregon (Figure 2-1). The Cascade Range and Deschutes National Forest lie west and south of the study area. Deep canyons of the Deschutes River and its major tributaries and level to gently rolling high desert terrain lie to the north and east. The Deschutes River is the major water course flowing south to north through the study area. Site E located northeast of Bend is the location of the wastewater treatment plant currently under construction.

Climate

The Bend-Madras area is characterized by a semiarid climate. Annual rainfall averages 10-12 inches with the majority falling in winter as rain or snow. Summers are typically hot and dry. Mean monthly temperatures range between 30°F in winter and 66°F in summer. Freezing temperatures can occur during any month of the year.

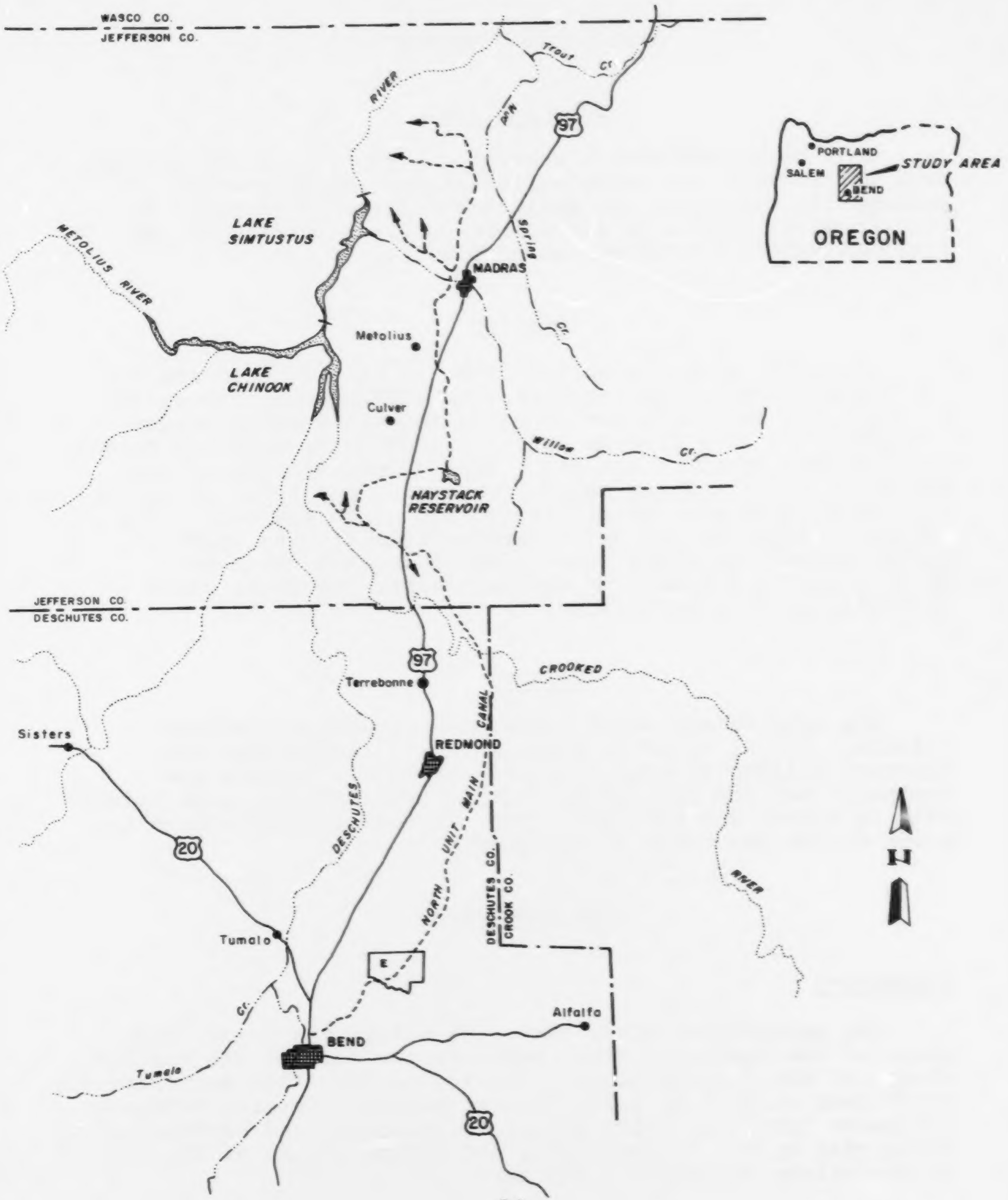
Land Resources

Topography

The Bend-Madras study area lies within the broad, flat plain of the Deschutes River basin at the foot of the eastern slopes of the Cascade Range. Elevations vary from approximately 3,600 feet at Bend to 2,200 feet at Madras. Several volcanic landmarks including Pilot Butte, Cline Butte, and Haystack Butte rise up out of the gently undulating plains of the basin to elevations exceeding 4,000 feet.

FIGURE 2-1

STUDY AREA



WASCO CO.
JEFFERSON CO.
Trout Cr.
RIVER
DRY
97
SPRING
Cr.
LAKE SIMTUSTUS
METOLIUS RIVER
MADRAS
Metolius
LAKE CHINOOK
Culver
Willow Cr.
HAYSTACK RESERVOIR
JEFFERSON CO.
DESCHUTES CO.
CROOKED
97
Terrebonne
Sisters
REDMOND
CANAL
MAIN
UNIT
NORTH
DESCHUTES
20
RIVER
DESCHUTES CO.
CROOK CO.
Tumalo
E
Cr.
Alfalfa
BEND
Tumalo
20
PORTLAND
SALEM
STUDY AREA
BEND
OREGON
N

The study area is dissected by the deep canyons of the Deschutes, Crooked and Metolius Rivers. Smaller streams of importance in the valley are Tumalo, Willow and Trout Creeks.

Geology

Below shallow valley soils are extensive basaltic lava flows commonly referred to as the "rimrock lavas" which form the cliffs bordering most canyons in the study area. These flows range from 50 to 150 feet in thickness. Lava tubes or caves, formed when molten lava flowed out from beneath a cooled and hardened crust, occur throughout the area.

Rimrock lava flows generally overlie a formation known as the Madras Formation, which exceeds 700 feet in thickness in northern portions of the study area. This formation is composed primarily of layers of pumice, ash, conglomerate sandstone, mudflow deposits and some interbedded lava flows.

At some locations the Madras Formation is underlain by Columbia River Basalt. This formation is a series of basaltic lava flows which underlie a large part of central Oregon and Washington.

Both the Madras Formation and Columbia River Basalt Formation overlie the John Day Formation, which is a sedimentary unit composed chiefly of tuff.

Soils

The most common soil type in the study area is Deschutes sandy loam, which occurs between mounds and ridges of outcropping basalt known as scabland (USDA, 1958). Soil depths range from several inches to 3 feet. This soil is derived from pumice sand. Because of its coarse texture, this soil tends to be well drained and runoff is slow.

Other common soils which occur mainly north of the Crooked River in Jefferson County are Agency gravelly loam and loam, Deschutes loamy sand, Era sand loam, Lamonta loam and sandy-clay loam and Madras loam and sandy loam. Most of these soils occur on nearly level to undulating upland plains and are derived from sedimentary and volcanic material. Drainage is moderate to rapid.

Land Use

A primary use of land within the study area is agricultural, with average farm sizes ranging from 276 to 1,344 acres (U. S. Department of Commerce, 1977). Where soils are suitable and irrigation water is available crops such as pasture grass, alfalfa, wheat, peppermint and potatoes are grown. In areas where cultivation is not economical, land is used primarily for cattle grazing. A large portion of range land within the study area is owned by the Bureau of Land Management and leased to private parties for livestock grazing or to other agencies, such as the Oregon National Guard, for training purposes. Remaining land in the study area is dominated by city and rural centers and some state and federal recreation and park facilities along the Deschutes River and elsewhere.

Water Resources

Surface Water Quality/Quantity

The major source of surface water in the study area is the Deschutes River. Major tributaries such as the Crooked and Metolius Rivers drain into Lake Billy Chinook created by construction of Round Butte Dam on the Deschutes River east of Madras. Smaller tributaries include Tumalo, Squaw and Willow Creeks.

During the irrigation season, April through October, almost the entire flow of the Deschutes River is diverted into six irrigation canals. At the Bend diversion dam, three canals, the Swalley, Pilot Butte and North Unit Main Canal divert in excess of 160,000 acre-feet of water for use north of Bend and in the Redmond and Madras areas, respectively. Upstream from the diversion dam the three remaining canals divert over 90,000 acre-feet of water for agricultural and domestic uses east and southeast of Bend and near Tumalo. In normal years during the irrigation season a minimum of approximately 12-30 cubic feet per second (cfs) flows over the diversion dam to meet water needs in the Deschutes River above Tumalo Creek (Perry, pers. comm.). Below Tumalo Creek and upstream of Lake Billy Chinook, flows in the Deschutes River increase to approximately 500 cfs.

From November to March water flow over the Bend diversion dam averages between approximately 500 and 1,000 cfs. During this period, all canals, with the exception of the North Unit Main Canal, have winter flows between 100 and 4,000 acre-feet per month to allow domestic water users to fill their cisterns.

Water quality in the Deschutes River below Bend usually meets the state standards for dissolved oxygen, temperature, turbidity, pH and coliform bacteria set by the Oregon Department of Environmental Quality for the basin (DEQ, 1977). However, substandard conditions do occur occasionally as a result of high total coliform levels from land runoff, turbidity during periods of high flow and high temperatures during summer low flows. Minor violations of standards for dissolved oxygen and pH have been reported. Algal blooms in Lake Billy Chinook are common in summer.

Water quality in the irrigation canals at their point of diversion at Bend is the same as that in the Deschutes River. In the North Unit Main Canal algal and aquatic plant blooms can occur in summer in canal segments with sluggish water movement (Wagner, pers. comm.). Water quality data from this canal show that pH and coliform counts can be seasonally high.

Groundwater Quality/Quantity

The primary source of groundwater in the Bend-Madras area is the Madras Formation. The regional water table lies at a depth of 500-600 feet at Bend and between 200-300 feet below the land surface at Redmond and Madras. Perched groundwater occurs within this formation at depths between 100-200 feet at Bend and less than 20 feet below the ground level at some locations near Madras (Sceva, 1968). Columbia River Basalt also serves as a source of groundwater wherever it underlies the Madras Formation. An artesian groundwater system lies below the regional water table. The John Day Formation has low permeability and generally does not transmit groundwater.

Groundwater in the study area is believed to generally flow in a northerly and northwesterly direction. Near Madras, the John Day Formation transects the Deschutes River basin forming a subsurface barrier that prevents further downstream movement of groundwater. This barrier forces all groundwater to discharge into the river system. Over 1,400 cfs discharges into the Crooked River Canyon and smaller amounts discharge into the Deschutes and Metolius Canyons. Some of this rising groundwater now discharges directly into Lake Billy Chinook.

From limited samples of wells in the study area by Sceva (1968) and the DEQ (unpublished data), groundwater quality meets drinking water standards established by the EPA. Groundwater in the Bend area is slightly alkaline, has a pH of 8 and is low in dissolved minerals. Average concentrations of dissolved minerals are higher in samples taken in the Redmond area and highest in samples from the Madras area (Sceva, 1968). Resampling by the DEQ also confirms this trend with increases in total dissolved solids, sodium concentration and specific conductance being most conspicuous (Shimek, pers. comm).

Water Supply and Beneficial Uses

Groundwater and surface water supplies in the study area are used primarily for agricultural, domestic and recreational purposes. Water for irrigation is supplied mainly by the large canals diverting the Deschutes River at Bend or by smaller diversions from the river downstream. Domestic supplies for the City of Bend come primarily from Tumalo Creek with two supplementary municipal wells located southwest of the city. The City of Redmond obtains its domestic supply from the Pilot Butte Canal and two wells in summer and primarily from wells in winter with the Deschutes River as a backup source. Madras obtains its water exclusively from two wells in winter with supplementary water from the North Unit Main Canal in summer. In rural areas domestic supplies are obtained from private wells, irrigation canals, springs or the Deschutes River.

Flood Hazards

Due to regulation of the Deschutes River by Crane Prairie and Wickiup Reservoirs upstream and the presence of steep canyon walls surrounding the river downstream from Bend, flood hazards in the study area are minimal. All canal systems are equipped with flow-regulating devices and spillways to prevent flooding of surrounding land. The North Unit Main Canal flows into Haystack Reservoir which acts as a regulating reservoir for the canal system.

Air Quality

Air quality in the Bend-Madras area is excellent. In 1976 those pollutants measured - total suspended particulates and sulfur dioxide - complied with standards as determined by DEQ monitoring (DEQ, 1976). On windy days, naturally entrained dust can increase the total suspended particulate level in the study area. However, these levels do not exceed DEQ air standards.

Biological Resources

Flora

The Bend-Madras area lies within the rain shadow of the Cascade Mountains. Summers are warm and dry with evapotranspiration far exceeding the precipitation in winter months. Most of the natural vegetation in the study area reflects these xeric conditions.

The most common and widespread plant community in the study area is western juniper savanna. The original juniper community consisted of an open stand of mature juniper trees with an understory of native bunchgrasses such as bluebunch wheatgrass, Idaho fescue, Thurber needlegrass, Sandberg bluegrass and Indian ricegrass. Perennial forbs such as milkvetch, buckwheat, yarrow and phlox occurred at various locations. Big sagebrush and bitterbrush were the dominant shrub species.

Domestic stock grazing on this plant community in the past resulted in major vegetational changes in understory species. Invading annuals such as cheatgrass, mustard and Russian thistle are now dominant with native bunchgrasses occurring at scattered locations. Rabbitbrush has increased considerably and is the dominant shrub in more disturbed stands.

Other plant communities of the study area include ponderosa pine forest, which intergrades with juniper habitat at the foot of the Cascade Range; riparian forest along stream beds dominated by willows, aspen and sedges; and agricultural land dominated by cultivated crops and irrigated pasture.

Fauna

The juniper community provides habitat for a variety of wildlife species that have adapted to the characteristic dry climate. Common resident species of birds include the red-tailed hawk, black-billed magpie, California quail, American robin and western meadowlark. Common summer residents are the brown-headed cowbird, mourning dove and ash-throated flycatcher. The Townsend's solitaire is a common winter resident. Characteristic mammals are the Townsend ground squirrel, Ord kangaroo rat, mountain cottontail, coyote and mule deer. Common reptiles include the western rattlesnake, gopher snake, western fence lizard and side-blotched lizard.

Common species of fish found in the Deschutes River and its tributaries are the rainbow and brown trout which are thought to spawn in the Deschutes River above Lake Billy Chinook (Fies, pers. comm.), brown bullhead, dolly varden and nongame species such as squawfish and bridge lip suckers. Additional game species - kokanee and small- and largemouth bass - occur in Lake Billy Chinook. Haystack Reservoir provides habitat for limited populations of rainbow trout, kokanee, white crappie and large- and smallmouth bass (Schwartz, pers. comm.). Most canals are presently equipped with fish screens at their diversion point from the river and thus support few fish.

Rare and Endangered or Threatened Species

No rare and endangered or threatened species of fish or wildlife are known to reside within the study area.

Archeological and Historical Resources

At the time of Euroamerican contact, the northern Paiute Indians occupied the regions in and adjacent to the study area. The Tenino tribe and others occupied areas to the north and west. The first recorded exploration of the Bend area was made in 1826 by trappers affiliated with the Hudson Bay Company.

In the mid-1800s, pioneers began to move into Oregon. One historical road, known as the Huntington Wagon Road, crosses north to south through the study area. The Meeks Wagon Train, one of the earliest wagon trains to enter central Oregon, is believed to have used this road.

Another road of historical importance in the study area is the Prineville-Bend Wagon Road established through continuous use by early residents of the area. The route was the source of mail and freight into Bend for many years.

Aesthetics

Much of the land in the study area is characterized by vast expanses of rolling, rocky, high desert terrain dissected by deep canyons of the Deschutes River and its tributaries. Numerous snowcapped peaks of the Cascade Range, most notably the Three Sisters, Mount Washington and Mount Jefferson provide an outstanding panoramic view from the study area. Other attractions of the area include Lava and Pilot Buttes and the numerous state parks such as Smith Rock State Park and The Cove-Palisades. A variety of recreational opportunities attract large numbers of both winter and summer vacationers.

The aesthetic qualities of the Bend-Madras area result primarily from the vast untouched nature of much of the surrounding high desert terrain coupled with the scenic beauty of the Deschutes River, noted for its numerous falls and steep canyons, and the snowcapped peaks of the Cascade Range.

Social Environment

In 1970, the City of Bend's population was 13,710 while the urban area population was 19,150. By 1974, the population had grown to 17,215 in the city and 25,690 in the urban area. Growth within the city during this period was attributable primarily to annexation.

Between 1962 and 1972, employment in Deschutes County increased by approximately 72.5 percent. Although the greatest growth in manufacturing employment occurred in the lumber and wood products industry, which has been the historical backbone of the local economy, the greatest total increase in employment during this period occurred in contract construction, primarily as a result of the increased employment opportunities in the manufacturing industry. The rapid growth from 1962 to 1972 has not been sustained, and the Bend area is currently experiencing a period of depressed housing construction.

Another principal manufacturing industry of the study area is livestock and dairy product processing. The recreation industry and retail trade are also significant employers.

Chapter 3

WASTEWATER CONVEYANCE, TREATMENT AND DISPOSAL SYSTEMS

Introduction

This section presents a brief summary of the existing wastewater handling system. Also discussed is the proposed wastewater handling system described in the City of Bend Facility Plan prepared by STR Engineers and the Design Definition Memoranda developed by BECON. The proposed collection and treatment works are the facilities included in Negative Declarations issued by EPA on April 5, 1977 and May 3, 1978. The disposal facilities considered in this EIS are for the treatment facility now under construction.

Historical Wastewater Handling Systems

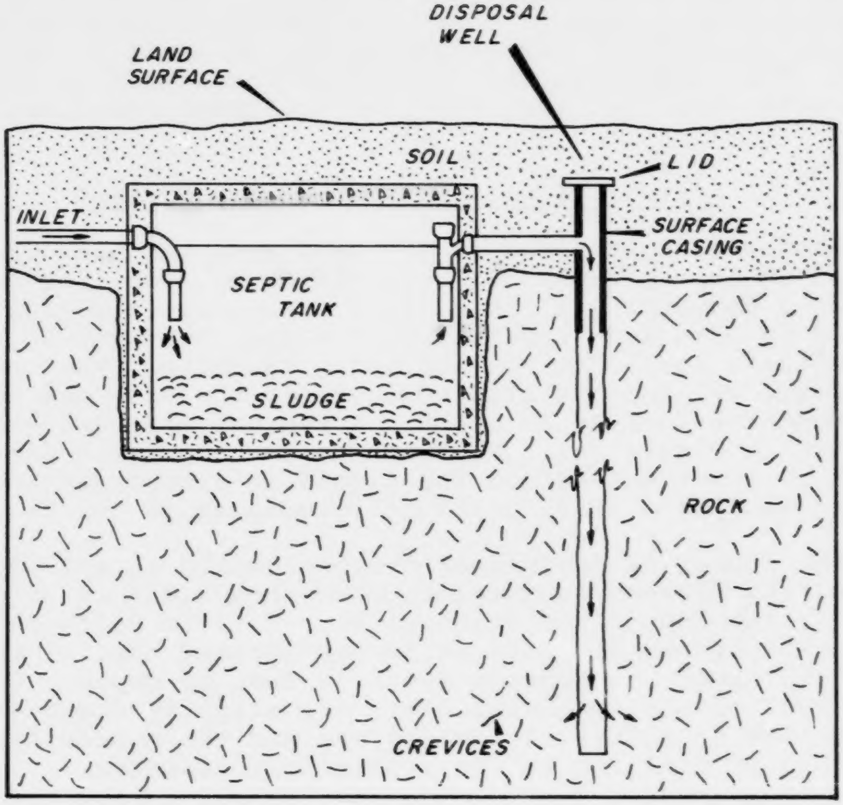
Wastewater generated in the Bend area was historically treated in septic tanks followed either by a drilled disposal well or a conventional drain field. Because this area is mantled by extensive basaltic lava flows, the pits for the septic tanks had to be blasted using dynamite. When needed, a disposal well was drilled adjacent to the tank and extended to as much as 60 feet in depth. A typical disposal system is shown in Figure 3-1. The wastewater receives a minimum amount of treatment before the liquid is discharged to the drilled well from which point it percolates to the groundwaters.

The number of individual disposal wells in and adjacent to the City of Bend amounted to more than 3,000 in 1968. By 1977, the number had risen to an estimated 6,500 wells. A majority of the disposal wells are located east of the Deschutes River and average about 50 feet in depth. Disposal wells west of the Deschutes River are slightly deeper due to the lack of surficial lava layers and the necessity therefore of drilling to the sedimentary deposits.

The City of Bend installed a small collection and treatment system circa 1912. This system served a part of the downtown area and some residential areas northeast of the city. Treatment was by an Imhoff tank located near the present treatment plant site. Effluent from the Imhoff tank flowed by pipeline and open ditch for use in irrigation and discharge to the lava sink hole, which is now in use by the city. Until

FIGURE 3-1

DIAGRAM OF A TYPICAL DOMESTIC SEWAGE DISPOSAL SYSTEM IN THE BEND AREA


DISPOSAL WELL
LAND SURFACE
SOIL
LID
INLET
SURFACE CASING
SEPTIC TANK
SLUDGE
ROCK
CREVICES

SOURCE: SCEVA, 1968

1970 the wastewater received a minimum of treatment and no disinfection prior to discharge. The flow was estimated at about 0.5 million gallons per day (mgd), with a suspended solids concentration of 50 to 200 mg/l. As a result of a study started in 1968, the wastewater treatment plant was constructed in 1970 and is now in use.

Existing Wastewater Handling Systems

The Bend urban area is served by six independent wastewater collection and treatment systems as well as the individual disposal systems (septic tanks) already discussed. The largest system is owned and operated by the City of Bend and provides service for approximately 10 percent of the city's population in a limited geographical area as shown in Figure 3-2. This system, which is principally a gravity system, terminates at the City of Bend wastewater treatment plant. The plant is a complete mix, activated sludge plant with a design capacity of 2.0 mgd, which was originally sized on a service area population of 20,000 people. Sludge digestion capacity, however, limits the plant capacity to some value less than 2.0 mgd. The original design also allowed for a future expansion to 4.0 mgd. The present annual average wastewater flow is about 0.5 mgd, which indicates that significant additional population or service connections have not been added to the system in the past 10 years.

The treated and disinfected effluent from the treatment plant is discharged to the same lava sink hole that was used before construction of the plant (see Figure 3-3). Discussions with the treatment plant operator indicate that no problems with regard to treated effluent disposal have ever occurred. Surcharges to 1 mgd for short periods of time apparently had no effect on the hydraulic capacity of the sink hole; however, long-term, high-volume tests have not been performed.

Sludge generated in the treatment plant is aerobically digested and mechanically dewatered to 12 to 14 percent solids. The solids are trucked to a sanitary landfill site for disposal. The treatment plant also receives and treats septic tank sludge and privy vault wastes. Treatment of these wastes is by course screening, aerobic digestion, dewatering and disposal of solids as already described. The receiving area for these wastes and the dewatering equipment are totally enclosed to minimize outside odor problems.

FIGURE 3-2

EXISTING SEWERAGE SYSTEMS

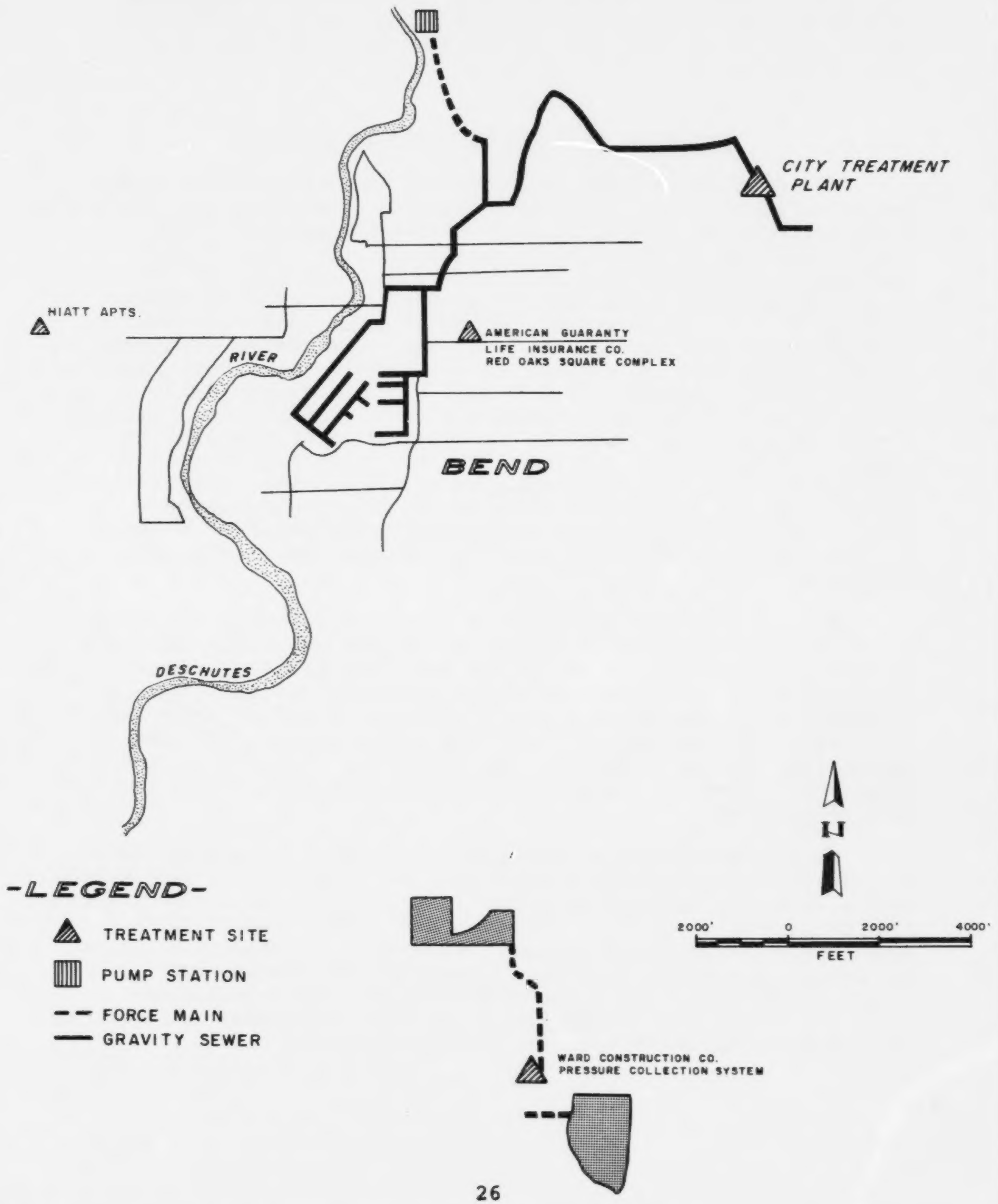
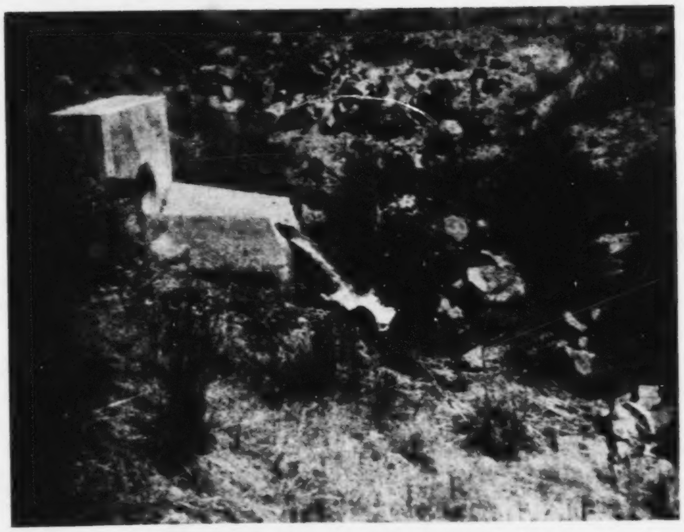
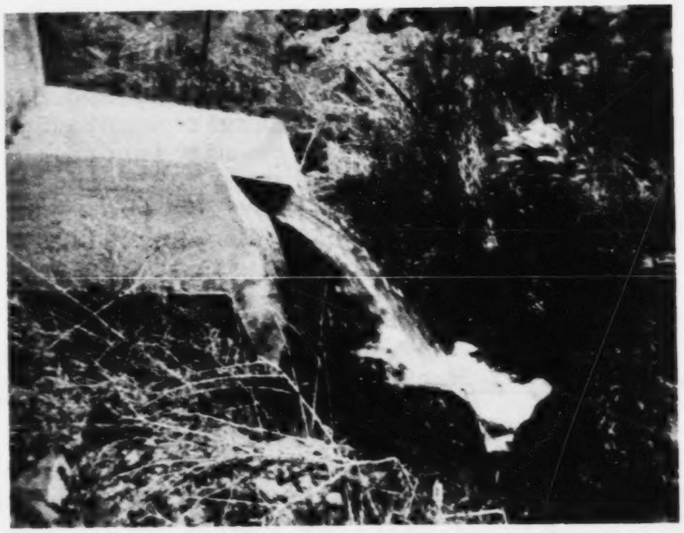

CITY TREATMENT PLANT
HIATT APTS.
AMERICAN GUARANTY
LIFE INSURANCE CO.
RED OAKS SQUARE COMPLEX
RIVER
BEND
DESCHUTES
N
-LEGEND-
TREATMENT SITE
PUMP STATION
FORCE MAIN
GRAVITY SEWER
2000' 0 2000' 4000'
FEET
WARD CONSTRUCTION CO.
PRESSURE COLLECTION SYSTEM

FIGURE 3-3

LAVA TUBE EFFLUENT DISPOSAL FROM THE EXISTING WASTEWATER TREATMENT PLANT





The second largest wastewater collection and treatment system is owned and operated by the Ward Construction Company. This system is totally pressurized and serves a housing development as located in Figure 3-2. Treated effluent is disposed of by spray irrigation on a once or twice weekly basis, as needed.

The remaining four systems are individual systems that serve commercial activities. These small systems are septic tanks followed by chlorination of the effluent prior to discharge to drill holes.

Future Wastewater Handling Systems

Because of the practice of discharging wastewater effluents, much of it essentially untreated, into deep lava sink or drill holes, considerable concern has been expressed about the hazards to public health through contamination of water supplies. The significant number of water wells in the area, as shown in Figure 3-4, and the estimated 6,500 drill holes for waste disposal scattered throughout the area indicates the proximity of contaminating sources to drinking water supplies. Most of the area in Figure 3-4 is considered to have severe septic tank limitations, which would result in poorer waste treatment prior to percolating to the groundwater. A 1968 study conducted by the Federal Water Pollution Control Administration (FWPCA), the predecessor to the EPA, concluded that discharge of septic tank wastes to lava sink or drill holes poses a potential hazard to groundwater quality.

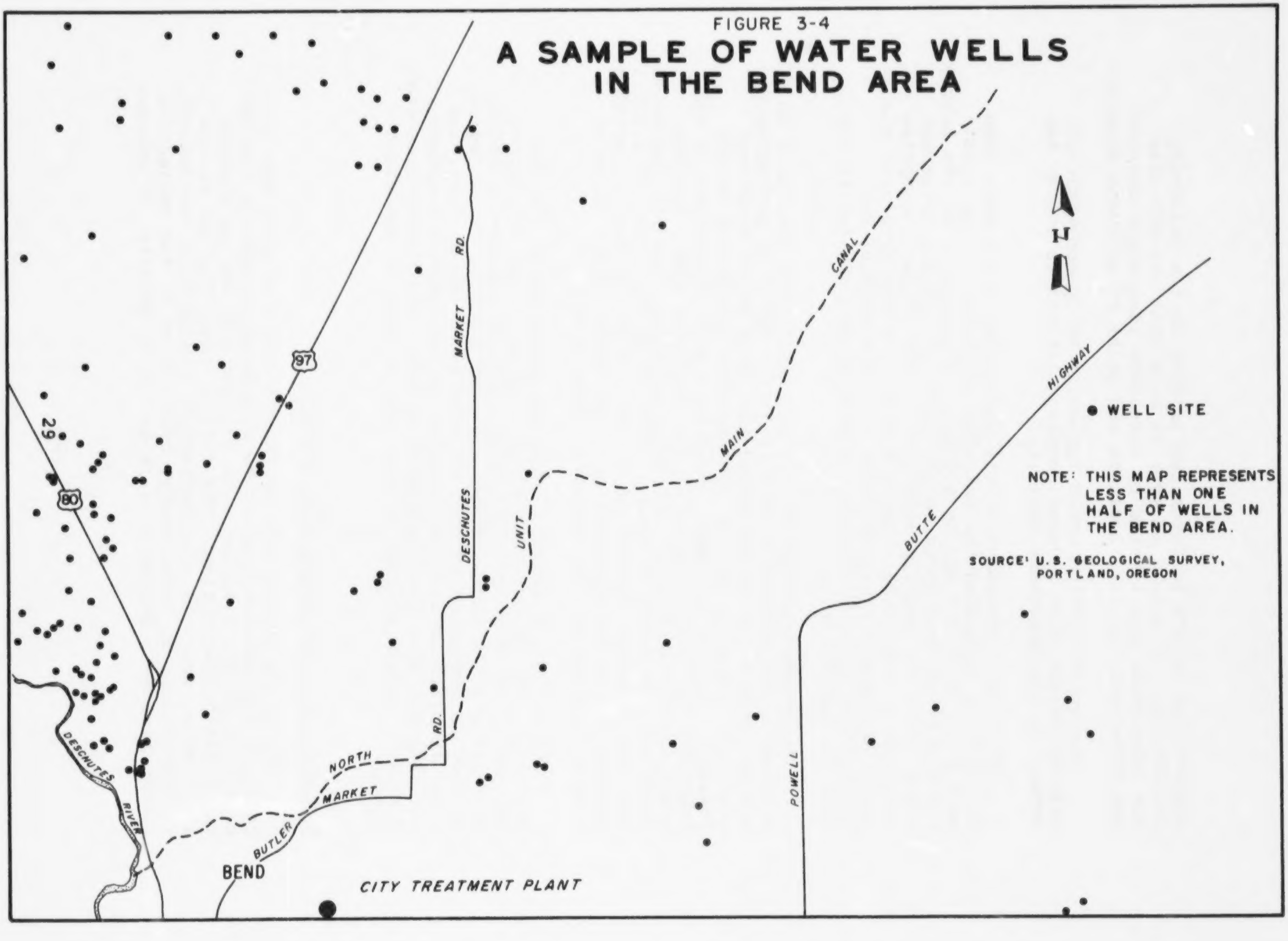
The DEQ has subsequently promulgated regulations for the control of waste disposal in lava sink holes (see Chapter 5). These regulations prohibit disposal of inadequately treated domestic wastes outside the Bend city limits after January 1975 and within the Bend urban area as of January 1980. Because of these regulations, it became imperative to determine the optimum method for collecting, treating and disposing of the wastes in an economical and environmentally sound way. Also, in the WPCF discharge permit issued to the city, DEQ required that a study be completed outlining the recommended method for handling the wastes for the Bend area. The Facilities Plan prepared by STR Engineers resulted in a recommended plan for the collection, treatment and disposal of wastes.

The Stevens, Thompson & Runyan Engineers Facilities Plan (STR)

The STR Facilities Plan recommended a regional approach to wastewater management in which the existing City of Bend wastewater treatment plant would be expanded and all other existing treatment plants would be phased out. The plan

FIGURE 3-4

A SAMPLE OF WATER WELLS IN THE BEND AREA


● WELL SITE
N
97
80
DESCHUTES RIVER
MARKET RD.
DESCHUTES RD.
NORTH MARKET
BUTLER MARKET
MAIN UNIT CANAL
BUTTE HIGHWAY
POWELL
BEND
CITY TREATMENT PLANT

NOTE: THIS MAP REPRESENTS LESS THAN ONE HALF OF WELLS IN THE BEND AREA.

SOURCE: U.S. GEOLOGICAL SURVEY, PORTLAND, OREGON recommended by STR is described briefly in the following paragraphs. It should be kept in mind that the STR plan was superseded and altered by the BECON plan which changes the treatment facility location and point of effluent disposal.

Sewage collection would typically be by conventional gravity sewers with several pumping stations to convey the sewage to the treatment facility.

Secondary treatment of the wastewater would have been provided by expanding the existing activated sludge treatment plant from 2.0 mgd to 6.0 mgd. Development in the Aubrey Butte area of Bend would be served by an interim treatment plant until the orderly expansion of the collection system extended to this area. Waste sludge from the treatment plant would be anaerobically digested (primary sludge) and aerobically digested (secondary sludge) and applied to the land in liquid form.

The treated secondary effluent would have been used to irrigate crops on Site C (Figure 3-5). Based on preliminary design parameters, an estimated 600 acres would have been required. However, during seasons when irrigation is not feasible, treated effluent would have been discharged to the Deschutes River downstream of the diversion dam. At these times, water is normally not being diverted from the Deschutes River and the dilution factor would be in the order of 1,000:1. The other possible method of effluent disposal during inclement weather was to the groundwater using either drill holes or lava sink holes at the treatment plant site.

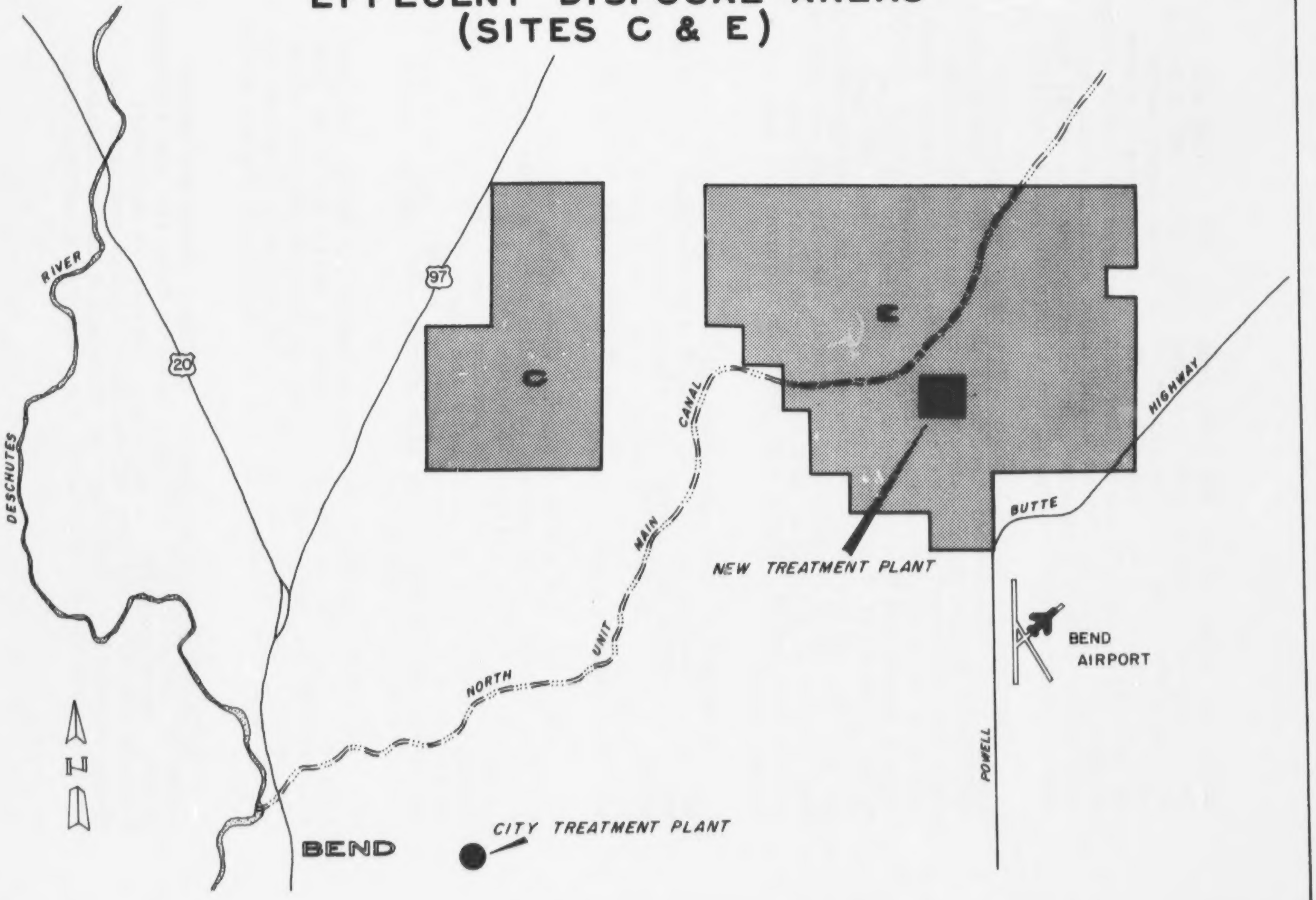
The foregoing regional plan was prepared by STR for the city. Subsequent to the publication of the STR report, the city elected to retain a consortium of engineers, BECON, to implement the plan. BECON prepared a series of 10 Design Definition Memoranda on various aspects of the project, and these resulted in a different plan for wastewater treatment and disposal than that described by STR. The revised regional treatment system adopted by the City of Bend is described below.

The Modified Facilities Plan (BECON)

The major change made to the STR regional plan was to relocate the treatment plant to Site E approximately 4 miles northeast of the existing site (Figure 3-5) and to abandon the existing facilities. The reasons given for the change in location are: 1) the encroaching residential development, 2) aesthetics, 3) lower energy consumption in the collection system because a larger area is served by gravity, 4) concern

FIGURE 3-5

TREATMENT PLANT LOCATIONS & PROPOSED EFFLUENT DISPOSAL AREAS (SITES C & E)


97
20
RIVER
DESCHUTES
C
E
CANAL
MAIN
UNIT
NORTH
HIGHWAY
BUTTE
POWELL
NEW TREATMENT PLANT
BEND
AIRPORT
BEND
CITY TREATMENT PLANT
N

about the capacity of the lava sink hole now in use and, 5) drill hole disposal within the Bend urban area, which has a greater potential for contamination of local water wells shown in Figure 3-4. The new wastewater management system is briefly described here. The EPA prepared an environmental assessment and, finding no significant environmental consequences, issued a Negative Declaration (May 3, 1978) for the new wastewater treatment and sludge disposal facility.

Description of Collection, Treatment and Disposal Facilities. Wastewater treatment would be by a conventional activated sludge plant (secondary treatment) followed by chlorine disinfection. Filtration using a dual-media (sand and coal filters) would be included, if necessary, to further reduce suspended solids thereby significantly improving effectiveness of the disinfection process. The effluent filtration system would be designed as a side stream operation so that it could be bypassed at times when it was not required. The treatment schematic of the proposed plant and the preliminary plant layout are shown in Figures 3-6 and 3-7, respectively.

Disposal of the anaerobically digested sludge would be by land spreading at Site E. Specially designed tank trucks would transport and spread the sludge evenly over the disposal area. Because the sludge would be in the 3 to 5 percent solids range, routine discing to integrate the sludge into the soils was not anticipated.

The projected average annual wastewater flow rate to the plant would be as shown in Figure 3-8. At the design capacity of 6 mgd, reached in about 1992, 2,190 million gallons of effluent would be produced annually. The average monthly variations in flow rate are shown in Table 3-1, in terms of a percentage of the total annual volume and also an estimated average daily flow during each month, based on a 6 mgd plant capacity.

According to the city plan prepared by BECON, effluent disposal would be to the subsurface by drill holes or lava tube cracks to the groundwater on an interim basis. *(Both the interim and final disposition for effluent disposal will depend upon the findings of this environmental impact statement.)*

Effluent Characteristics. Effluent characteristics refer to the probable effluent quality from the new treatment plant. Determination of effluent quality is difficult without the availability of detailed design criteria and plant schematics. However, an indication can be obtained from the operative records of the existing treatment plant.

FIGURE 3-6

SCHEMATIC DIAGRAM OF PROPOSED TREATMENT PLANT

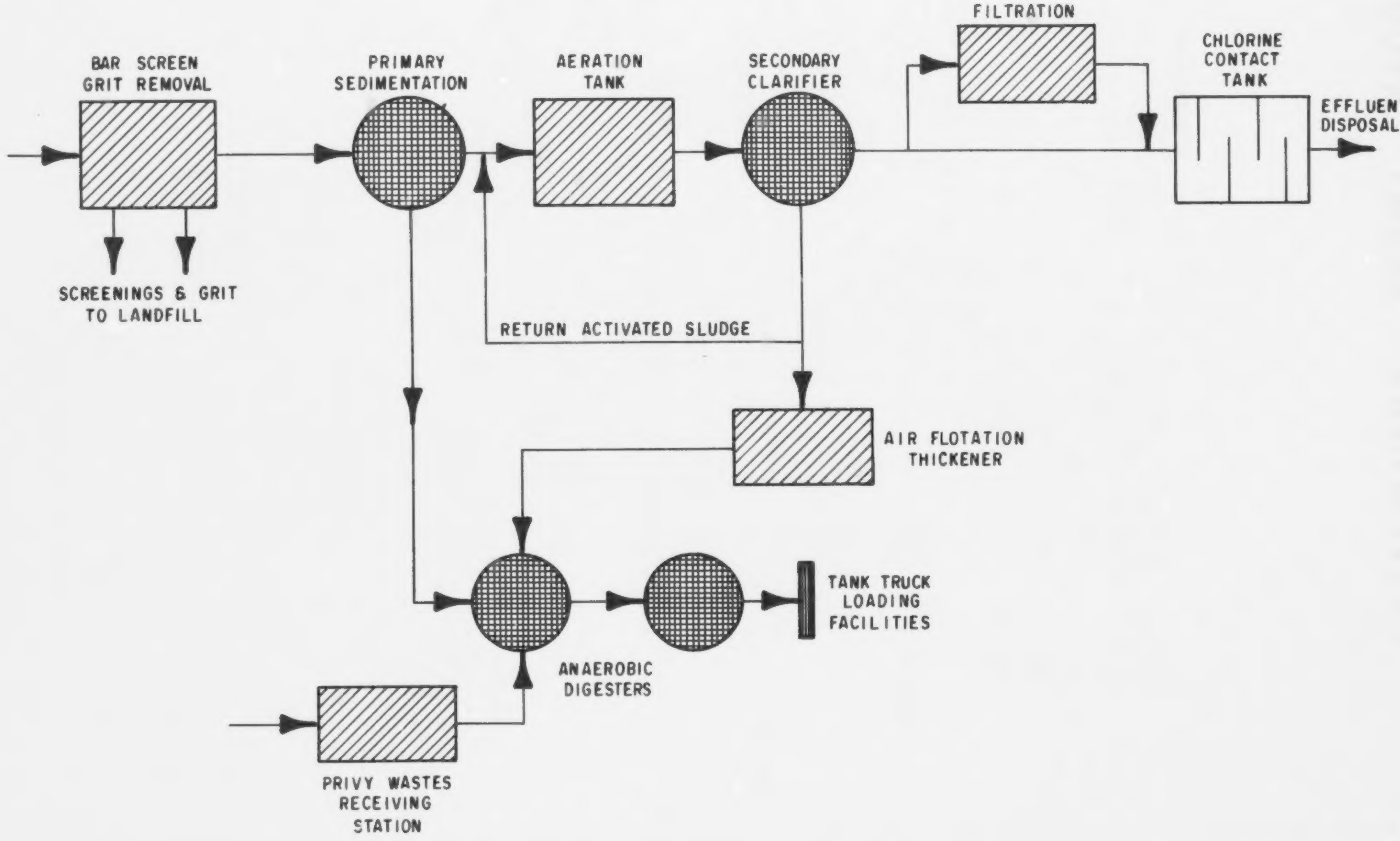
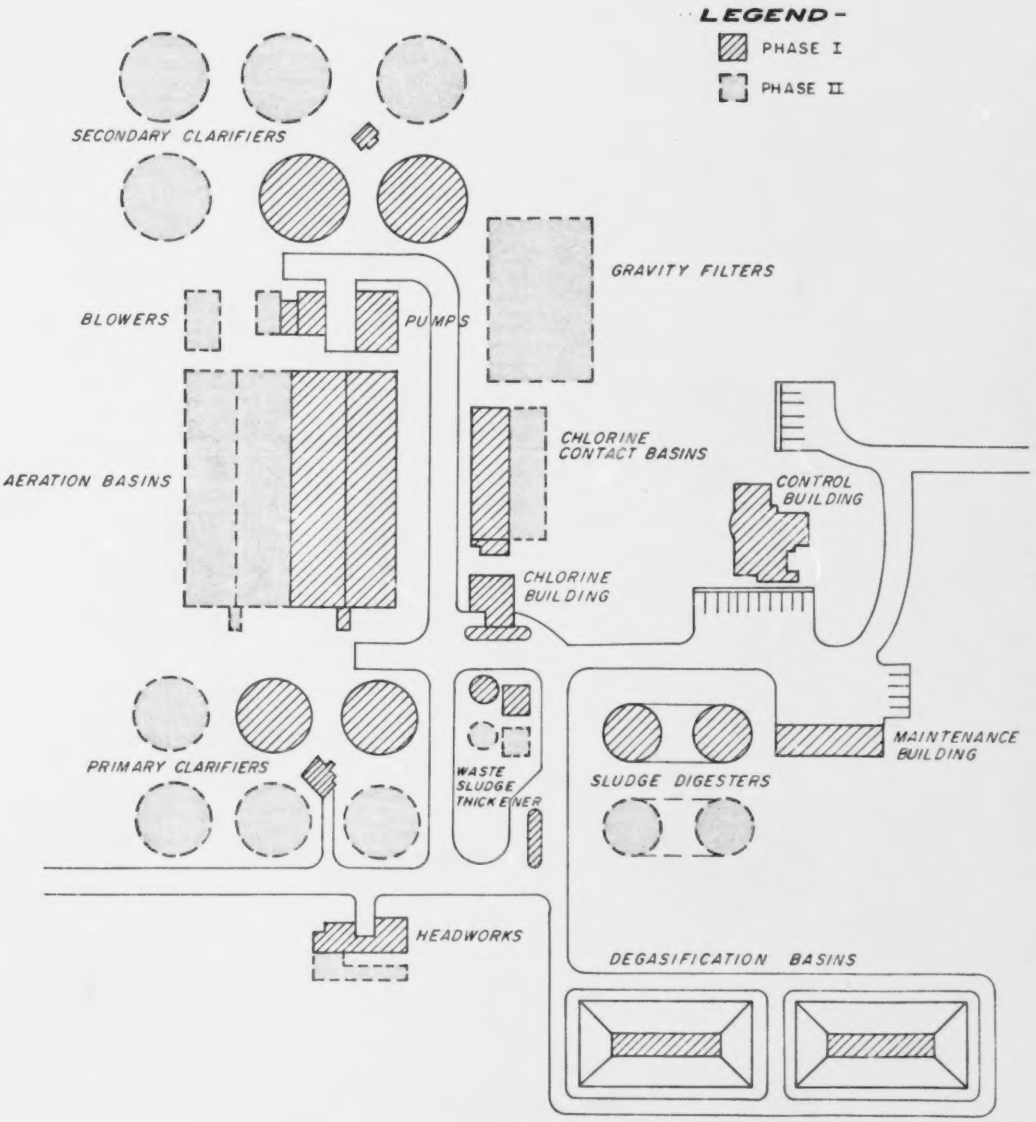

BAR SCREEN
GRIT REMOVAL
SCREENINGS & GRIT
TO LANDFILL
PRIMARY
SEDIMENTATION
AERATION
TANK
SECONDARY
CLARIFIER
FILTRATION
CHLORINE
CONTACT
TANK
EFFLUENT
DISPOSAL
RETURN ACTIVATED SLUDGE
AIR FLOTATION
THICKENER
ANAEROBIC
DIGESTERS
TANK TRUCK
LOADING
FACILITIES
PRIVY WASTES
RECEIVING
STATION

FIGURE 3-7

PRELIMINARY PLANT LAYOUT

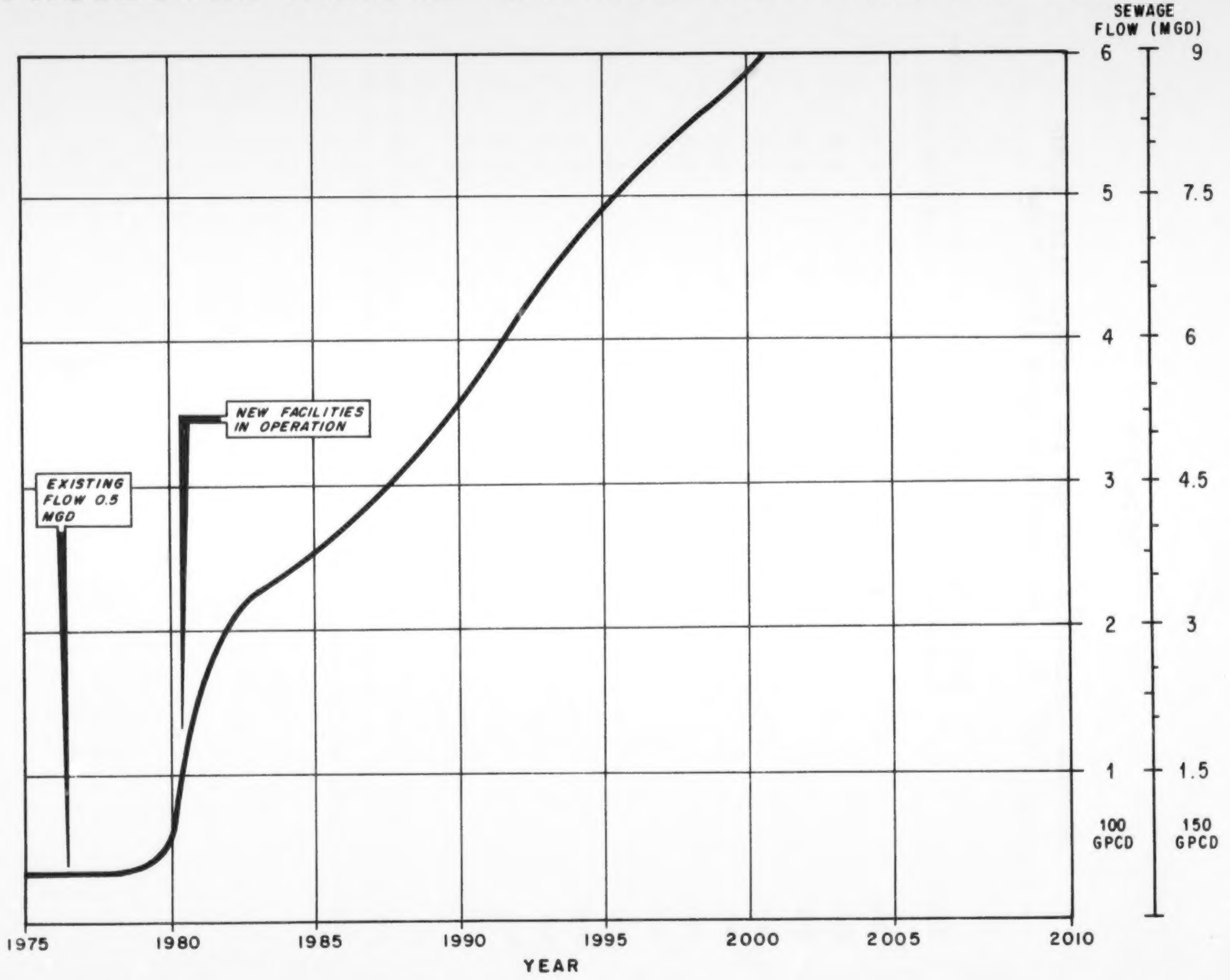


LEGEND-
▨ PHASE I
⬚ PHASE II
SECONDARY CLARIFIERS
GRAVITY FILTERS
BLOWERS
PUMPS
CHLORINE CONTACT BASINS
AERATION BASINS
CONTROL BUILDING
CHLORINE BUILDING
MAINTENANCE BUILDING
PRIMARY CLARIFIERS
WASTE SLUDGE THICKENER
SLUDGE DIGESTERS
HEADWORKS
DEGASIFICATION BASINS

SOURCE: BECON, AUGUST, 1979

FIGURE 3-8

PROJECTED ANNUAL AVERAGE WASTEWATER FLOWS



SOURCE: BECON DESIGN DEFINITION MEMORANDUM NO.7, AUGUST 1977

Table 3-1

MONTHLY WASTEWATER VOLUMES AND AVERAGE DAILY FLOWS (BASED ON 6 MGD ANNUAL AVERAGE DAILY FLOW)

Month[1]	Average Monthly Volume Percent of Total Annual	Average Daily Flow mgd for Month
Jan	8.05	5.7
Feb	7.36	5.8
Mar	8.22	5.8
Apr	8.05	5.9
May	8.57	6.1
June	7.97	5.8
July	9.26	6.5
Aug	9.51	6.7
Sept	8.54	6.2
Oct	8.40	5.9
Nov	7.99	5.8
Dec	8.07	5.7

---

[1] The summer months, as used in this EIS, are May through October and the Winter months are November through April.

Also, effluent criteria can be established that will ensure at least secondary treatment levels. These are presented in the following discussion.

The existing wastewater treatment plant does not have extensive records of effluent qualities. Information available has been summarized in Table 3-2. This information is based on data presented in the facilities plan and also on limited analyses conducted by Century West Laboratories and presented in the BECON Design Definition Memorandum Number 2.

Table 3-2

SUMMARY OF EFFLUENT QUALITY
(City of Bend Wastewater Treatment Plant)

Parameter	Effluent Quality (mg/l)
BOD	5-10
Boron	0.43
Calcium	7.0
Chloride	29.0
Chlorine Residual	1-2
COD	37.0
Conductance, MMO[1]	363
Magnesium	1.9
Nitrogen	
Total	13.0
Ammonia	*
Nitrate	*
pH, units	6.7-8.0
Phosphate	*
Potassium	9.3
Sodium	52.0
Solids, Total Suspended	10-20
Solids, Total Dissolved	352
Sulphate	15
SAR, dimensionless	4.2
Bicarbonate alkalinity as $CaCo_3$	123

* Not measured.

Alternative Effluent Disposal and Reuse Systems

Chapter 4

ALTERNATIVE EFFLUENT DISPOSAL AND REUSE SYSTEMS

Introduction

Effluent disposal alternatives considered in detail in the facility plan and additional feasible alternatives added for consideration are reviewed in this chapter. The facilities plan presented the alternatives considered in terms of total systems, which therefore included wastewater collection and treatment followed by effluent disposal methods by one of several methods. However, in this EIS, only effluent disposal methods are being considered. All treatment facilities required in addition to conventional secondary treatment using the activated sludge process, followed by chlorine disinfection, are considered as part of the effluent disposal alternative. This would also include the costs, if any, for secondary treatment facility enlargement as a result of recycled flows that may be present if higher levels of treatment are required. An example of such enlargement might be the backwash solids captured in the filters and returned to the primary sedimentation basins.

Screening of Effluent Disposal and Reuse Alternatives

The following are the effluent disposal options that were initially considered in the STR Facilities Plan. The alternatives to be evaluated were based on these options.

- Discharge to the Deschutes River during the winter months (November to April) only
- Discharge to an Irrigation Canal during the summer (May to October) only
- Land application of effluent by one of three methods
    1. Spray irrigation
    2. Overland flow
    3. Infiltration/Percolation Ponds
- Evaporation of the effluent by discharge to storage ponds having a large surface area.
- Discharge to drill holes (relatively shallow wells) for a regional treatment facility (in accordance with Oregon Administrative Regulations)
- Discharge to deep well fields for regional treatment facilities. (Wells would be totally encased and penetrate the lower aquifer by at least 100 feet)

- Reuse of effluent by two methods
  1. Industrial reuse such as boiler make-up water or cooling waters
  2. Domestic or potable reuse by treating and returning the effluent to the water supply system

Based on these seven options for effluent disposal the facility planner selected four methods for detailed evaluation in coordination with the wastewater collection and treatment alternatives. The industrial reuse option was dropped from consideration by the facility planner, because there are no existing or potential industrial users in the Bend area to take the projected quantities of effluent. The domestic reuse option was dismissed from consideration because of the potential health risks and the high costs of treatment. Also, the City of Bend is served by a reliable source of high quality water. Deep well disposal and use of evaporation ponds were dismissed in the facilities plan without detailed explanation.

STR Proposed Alternatives

The four effluent disposal alternatives selected by STR are described below. All four are for a regional treatment facility to be located at the site of the existing treatment plant.

Year-round Drill Hole Disposal. Under this alternative, effluent would be discharged to drill holes on a continuous basis. The treatment level considered was secondary, using activated sludge followed by chemical coagulation, clarification and filtration and finally, disinfection using chlorine. Although the facilities plan indicates treatment for nitrogen control as well, the treatment systems finally reported and costed do not include this option.

Combination of Drill Hole and Irrigation Canal Discharge. Effluent disposal would be to the North Unit Main Canal during the summer months and to drill holes during the winter months when the canal was not utilized. Treatment for discharge to the irrigation canal would be secondary treatment followed by chlorine disinfection. Treatment for drill hole disposal would be secondary followed by filtration and chlorine disinfection.

Combination of Disposal to the Irrigation Canal and Deschutes River. Secondarily treated (activated sludge) and disinfected effluent would be discharged to the North Unit Main Canal during the summer months and to the Deschutes River during the winter months.

Land Application of Effluent by Spray Irrigation. Secondarily treated (activated sludge) and disinfected effluent would be used to irrigate crops at alternate sites on a year-round basis. For this option, three different sites were evaluated as three separate effluent disposal alternatives. No temporary storage reservoir is mentioned as being included in these options. The three sites would be under control of the city.

The purpose and intent of the initial screening process is to eliminate those alternatives that obviously do not meet the cost-effectiveness requirements, in which case they may be excessively costly or have overriding adverse environmental or societal consequences. The goal of any evaluation procedure is to identify the most environmentally, technically and economically sound alternative. Final judgement about the recommended alternative is almost always subjective and based on the total cost to society. This initial screening is based largely on monetary costs, which are relatively easy to develop and require little site evaluation. However, any alternative that may harbor an overriding adverse environmental impact could also be eliminated unless satisfactory mitigation measures could be taken.

The criteria used by the Facilities Planner to screen the effluent disposal methods included minimizing, or preferably eliminating environmental or public health hazards; reliability and flexibility to accommodate future situations; total annual costs, present worth costs and costs to the homeowner; and finally site availability. Other concerns such as resource commitments and social objectives were also considered when screening the possible alternatives.

Four alternatives for the disposal of treated municipal wastewater were analyzed in detail by the facilities planner (STR) who subsequently eliminated two methods, drill hole disposal and the combination of canal and drill hole disposal, on the basis of cost and potential groundwater contamination. The final recommended alternative was land application by spray irrigation on Site C.

As previously stated in Chapter 3, the city retained BECON to implement the facilities plan. After more detailed site evaluation by BECON (Design Definition Memorandum #5), Site C was found unsuitable for land application of effluent. On the basis of relocation of the treatment plant to Site E and further analyses of the land application alternative, BECON recommended subsurface effluent disposal on an interim basis, with a final disposal method to be selected at a later date.

Alternatives of effluent disposal described in the following section are intended to be utilized as long-term disposal options. The interim effluent disposal option chosen for funding by EPA, in the event that the treatment plant is ready for start-up prior to completion of this EIS, would have to be compatible with the long-term effluent disposal option ultimately chosen.

Proposed Effluent Disposal and Reuse Alternatives

As a result of relocation of the treatment plant to Site E, the basis used by STR for discarding alternatives has been altered. For example, the estimated plume of contamination for drill hole disposal would be relocated to the northeast and might therefore have less chance of affecting groundwater supplies. Thus, based on disposal options considered in the STR facilities plan, including modifications by BECON and Jones & Stokes Associates, Inc., there are five basic effluent disposal options potentially suitable for the new wastewater treatment plant. These are:

1. Subsurface disposal via drill holes or infiltration from the surface.
2. Discharge to the Deschutes River.
3. Discharge to sealed evapotranspiration ponds.
4. Land application by spray irrigation.
5. Discharge to the North Unit Main Canal.

Subsurface Disposal

This alternative would involve year-round conveyance of effluent by pipeline for discharge to a series of drill holes on Site E or to infiltration ponds. Effluent discharged to drill holes would receive secondary treatment and chlorine disinfection followed by sand filtration. The filtration system would be designed as a side stream operation so that it could be bypassed when not needed. Effluent discharged to infiltration ponds would not receive filtration. Anticipated effluent quality in terms of BOD, suspended solids and coliform bacteria is given in Table 4-1.

For drill hole disposal, effluent would travel by gravity flow through a pipeline to a series of drill holes a short distance from the treatment plant. The number of drill holes, their depth or exact location has not been established pending detailed geological surveys recently completed on Site E by BECON (BECON, preliminary draft, September 1979).

Table 4-1

ANTICIPATED EFFLUENT QUALITY FOR EACH MAJOR ALTERNATIVE[1]

Disposal Alternative	BOD mg/l	Suspended Solids (mg/l)	Coliform MPN/100 ml
Subsurface:			
Drill holes	10	10	<10
Surface Infiltration	30	30	1,000
Deschutes River	10	10	2
Evapotranspiration Ponds	30	30	1,000
Land Application by Spray Irrigation	20	20	20
North Unit Main Canal	10	10	<10

[1] SOURCES:

Drill holes - See Appendix 6 - DEQ letter dated February 8, 1979.
Infiltration - estimated quality.
Deschutes River - See Appendix 4 - Minimum Design Criteria - Deschutes River Basin
Evaporation Ponds - estimated quality.
Land Application - See Chapter 5 - current WPCF permit.
North Unit Main Canal - See Appendix 6 - DEQ letter dated February 8, 1979.

Discharge of effluent to infiltration ponds would involve gravity flow of effluent by pipeline to a series of ponds located on Site E, or to a natural closed depression located east of Site E (Figure 4-1). Based on preliminary data (Cooper-Clark & Associates, 1979), the clear water infiltration rate in the depression was measured to be an average of 7/8 inch per hour or 147 inches per week. However, use of wastewater substantially reduces the amount of water that can be percolated. For purposes of this study, a rate of 15 percent of the clear water rate or 22 inches per week was used to determine the land area required. (A value of 5 to 25 percent of the clear water rate is recommended by EPA.) Local evaporation records were used to determine the amount of evaporation that might be experienced. The evaporation rate was found to be negligible compared to the percolation rate. Allowing for peak flows and reduced infiltration capacity, about 85 acres would be needed to dispose of the wastewater.

Development of the infiltration pond would require the construction of three or more cells in the infiltration area, which would allow maintenance of one cell while the others were in operation. The cells would be separated by dikes or berms. Native materials would be used to construct the berms, which would be about 4 feet high with a crest width of 6 feet. Some sand and gravel would be imported to provide a minimum percolation depth of 3 feet. See Appendix 1 for more detailed facilities planning on this alternative.

Discharge to the Deschutes River

Treated wastewater under this alternative would be pumped through a pipeline to the Deschutes River on a year-round basis. This would be accomplished using a pumping station and a 6.7-mile forcemain along the right-of-way of the North Unit Main Canal. Effluent would be discharged downstream of the Bend diversion dam (Figure 4-2). The treatment system would include sand filtration and chlorine disinfection. Anticipated effluent quality is given in Table 4-1.

Discharge to Sealed Evapotranspiration Ponds

Although this alternative was rejected in the STR facilities plan, it has been reconsidered in this EIS in modified form at the request of a local citizen, Mr. Gordon Priday. The Priday alternative would involve construction of a series of sealed ponds interconnected by a small canal system. Effluent would flow by gravity through the pond series which would extend in a northeasterly direction from the wastewater treatment plant. Each pond would be constructed and managed to establish wildlife habitat.

FIGURE 4-1

POTENTIAL LOCATION OF INFILTRATION POND & GRAVITY PIPELINE

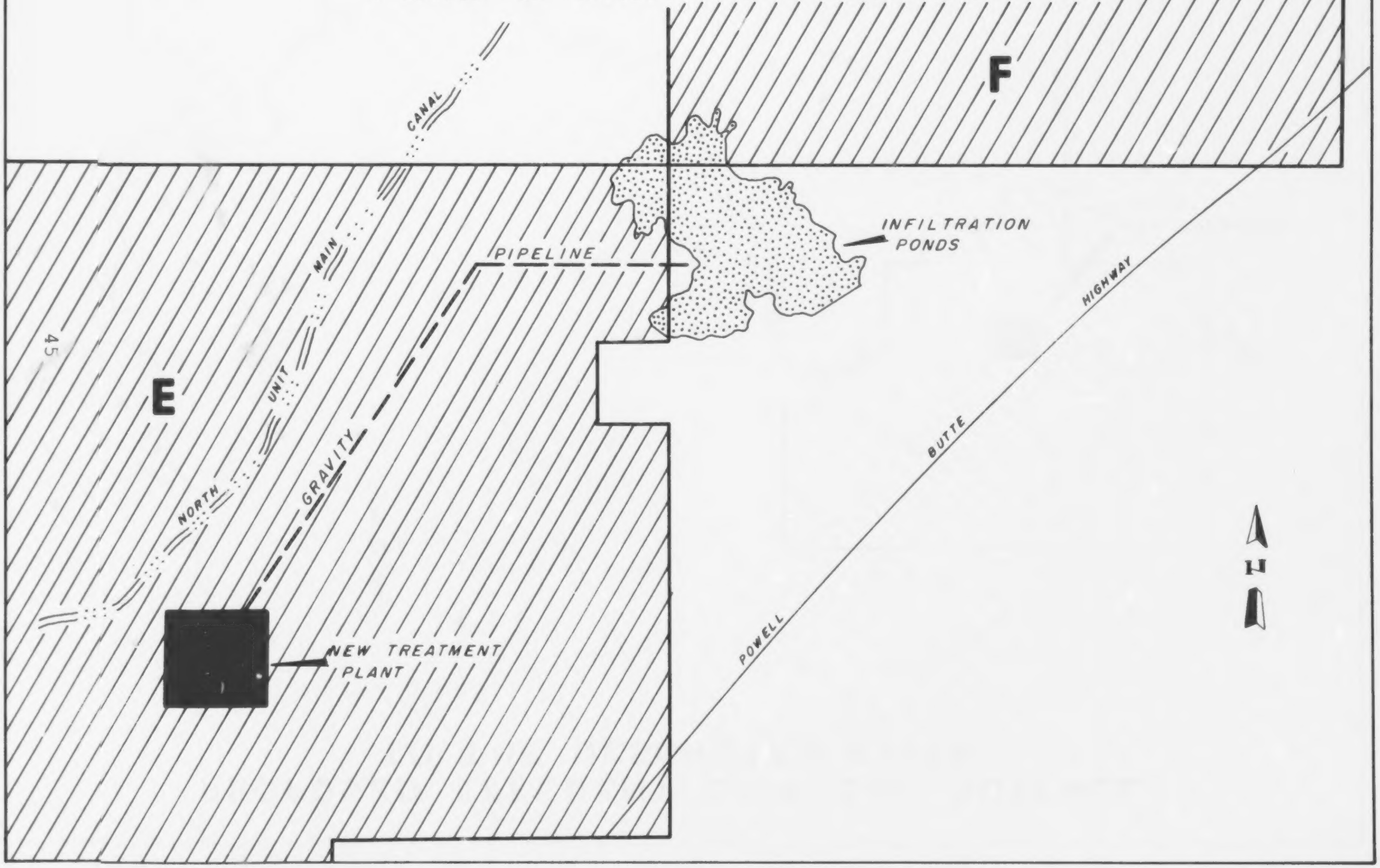
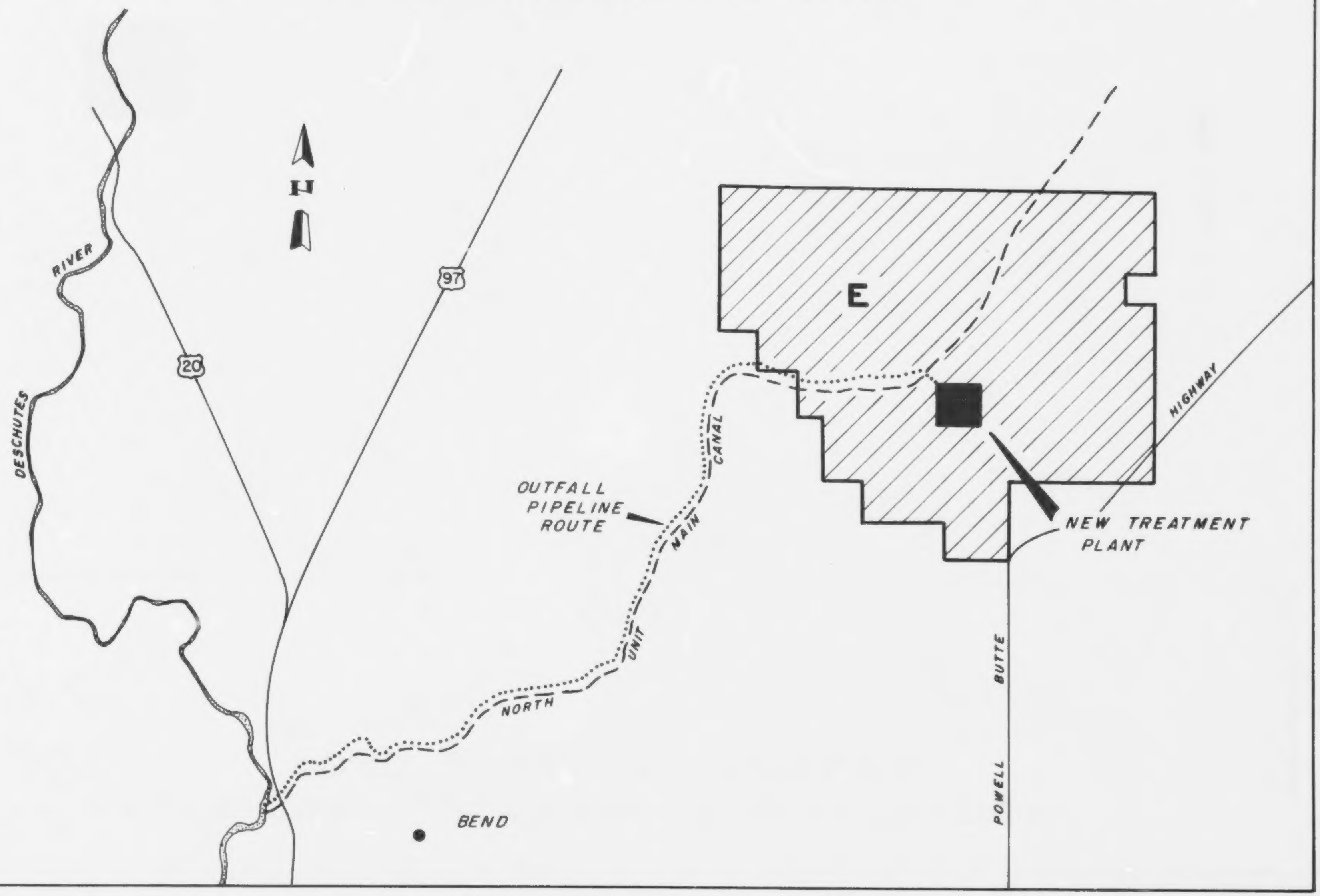

F
CANAL
MAIN
UNIT
NORTH
E
PIPELINE
GRAVITY
INFILTRATION PONDS
NEW TREATMENT PLANT
HIGHWAY
BUTTE
POWELL
N

FIGURE 4-2

PROPOSED EFFLUENT DISPOSAL OUTFALL TO THE DESCHUTES RIVER


N
DESCHUTES RIVER
20
97
E
HIGHWAY
OUTFALL PIPELINE ROUTE
NORTH UNIT MAIN CANAL
NEW TREATMENT PLANT
POWELL BUTTE
BEND

Preliminary evaluation of the Priday alternative revealed that approximately 4,000 acres of sealed ponds having a depth of 5 feet would be necessary to evaporate yearly effluent production. Because of the high acreage requirement, the Priday alternative was modified to include peak flow and cold season use of infiltration ponds described under subsurface disposal.

Under this alternative, effluent would flow by gravity pipeline to the first marshes and the infiltration pond (Figure 4-3). Subsequent downstream flow to additional wetlands would utilize small cement-lined canals. Wetlands would be developed utilizing natural depressions as much as possible for embankments. Artificial embankments, or berms, would be constructed as described for infiltration ponds. Marshes would have a maximum depth of 12 feet and would be sealed with bentonite or other clay material. Aquatic vegetation, native to the Bend area, would be planted in each wetland area.

Marsh basins would be sized to evaporate over 3 feet of effluent per year during the months of April through October. Approximately 1,270 acres would be needed. Marsh basins would evapotranspire over half of the effluent during the year. The balance would be discharged to infiltration basins with an estimated 35 acres required. See Appendix 2 for more detailed facilities planning on this alternative.

Land Application by Spray Irrigation

Under this alternative effluent would receive secondary treatment, then would be pumped to either center-pivot or fixed-head (solid-set) irrigation units for spraying onto the land. Anticipated effluent quality is given in Table 4-1.

The sprinkler system would be designed to work around rock outcrops, thereby eliminating the expense of rock removal. The disposal system also would include storage reservoirs to hold the effluent during periods of freezing weather when the irrigation system could not be operated.

Spray irrigation disposal of project effluent would ultimately require 1,350 acres to accommodate a treatment plant capacity of 6 mgd. Site E (3,000 acres) contains approximately 800 acres of suitable land for irrigation. The remaining 550 acres would be developed on Site F (2,560 acres) as needed (Figure 4-4). Four 100 acre-foot reservoirs would be needed for effluent storage during periods of freezing temperatures.

FIGURE 4-3

POTENTIAL LOCATION OF PIPELINE/ CANAL ROUTE & PONDED AREAS

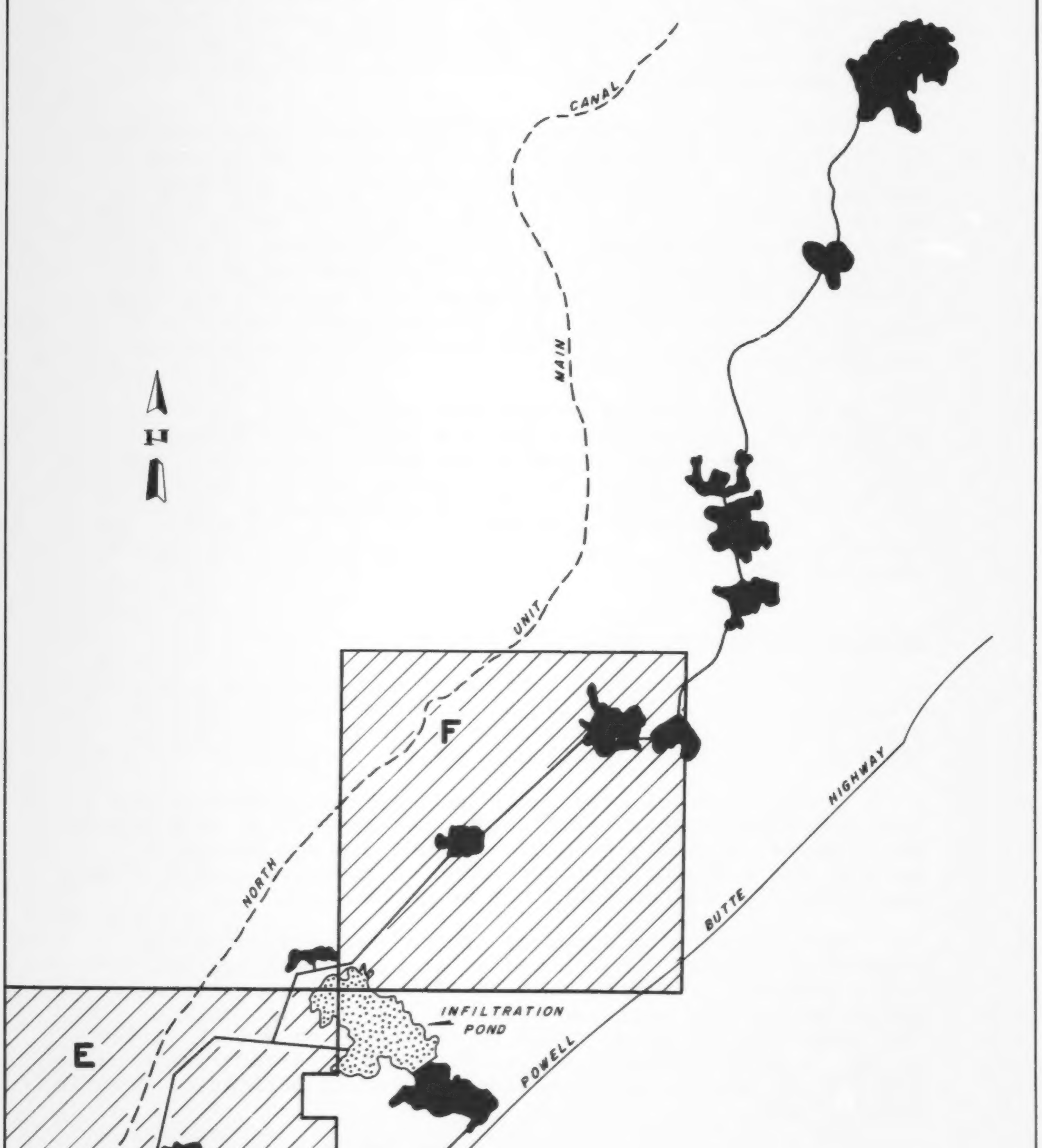
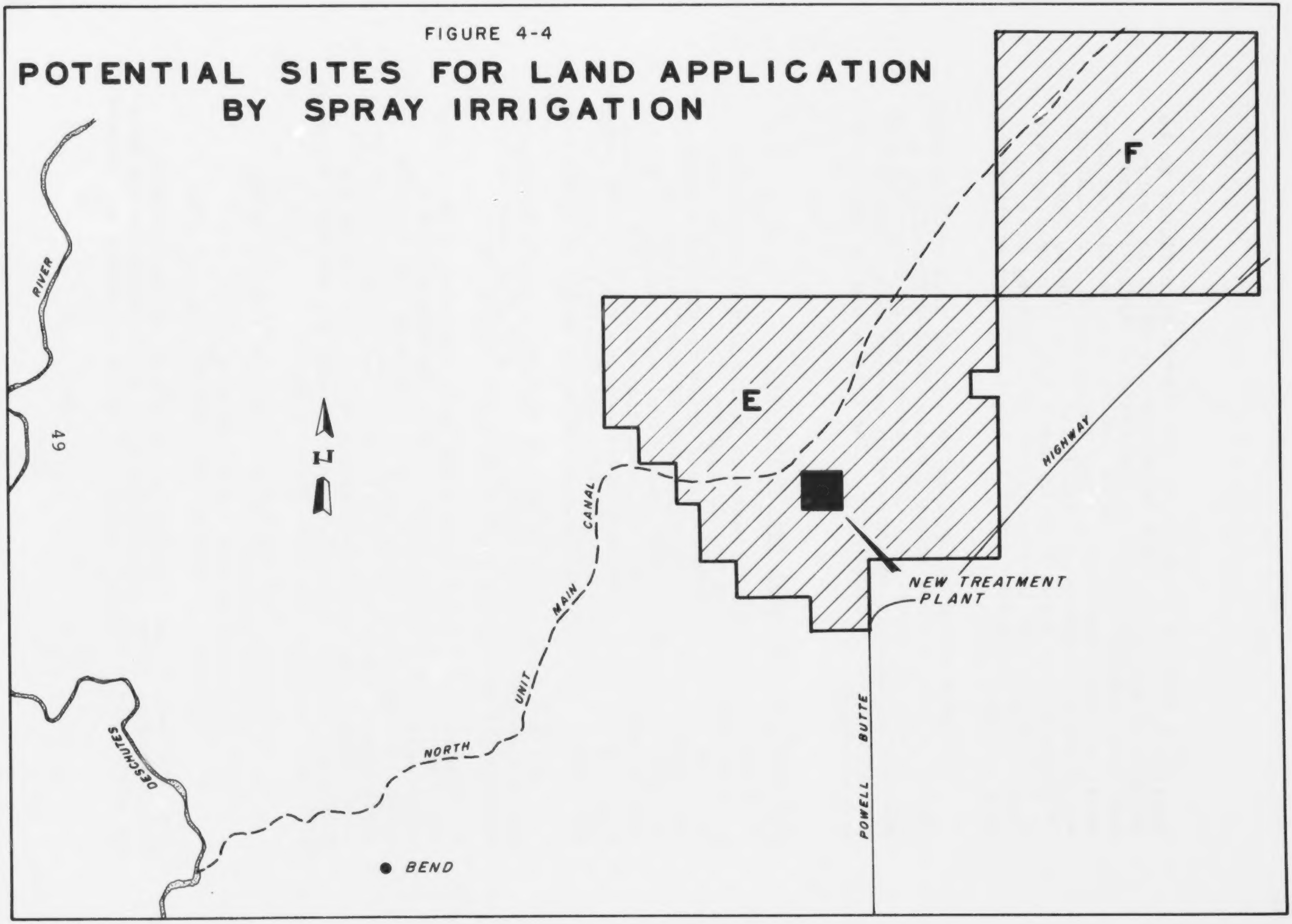

N
NORTH
UNIT
MAIN
CANAL
F
E
INFILTRATION POND
NEW TREATMENT PLANT
POWELL
BUTTE
HIGHWAY

FIGURE 4-4

POTENTIAL SITES FOR LAND APPLICATION BY SPRAY IRRIGATION


F
E
HIGHWAY
NEW TREATMENT PLANT
POWELL BUTTE
CANAL
MAIN
UNIT
NORTH
BEND
RIVER
DESCHUTES
N

Site loading factors, or quantities of effluent to be applied to the soil, were determined by BECON in Design Definition Memorandum #5 on the basis of hydraulic and nutrient loading rates. Other constraints considered were metal and salt quantities, crop requirements for moisture and climatic restraints. The basic site-loading factor determined from these studies was a hydraulic loading rate of 5 acre-feet per acre-year. At this loading rate, no other constraints were found to limit effluent application on a suitable site.

Effluent would be applied to a cover crop such as reed canary grass, fescue, orchard grass, meadow foxtail or a combination of these. No final selection of crops has been made as to the most suitable with respect to maximum water consumption and nitrogen use. The crop would be harvested and marketed.

Discharge to the North Unit Main Canal

The alternative is based on year-round discharge of treated wastewater to the irrigation canal. Due to the location of the treatment plant, which is currently under construction and the principal use of canal water for irrigation, the North Unit Main Canal was considered more appropriate for effluent disposal than other canal systems in the Bend area. Effluent would undergo secondary treatment followed by chlorine disinfection and filtration prior to discharge. Effluent quality would be as given in Table 4-1.

The effluent would be pumped through a short forcemain and discharged directly to the canal. The flow rate would average approximately 9 cubic feet per second (cfs).

Because the North Unit Main Canal operates only during the irrigation season, roughly April through October, modifications to year-round canal discharge are included under this alternative to avoid discharging effluent to an empty canal. That is, effluent would be discharged to the canal during the irrigation season only, and one of the following alternatives would be utilized for effluent disposal from approximately November through March.

1. Discharge to the subsurface (i.e., drill holes or infiltration).
2. Discharge to the Deschutes River.
3. Discharge to storage reservoirs.

The method and location of discharge to drill holes, the Deschutes River and infiltration ponds would be the same as previously discussed under each major alternative. However, because effluent would be discharged only 5 1/2 to 6 months of the year to these locations, the annual effluent discharge would be 870 million gallons, with the remaining 1,320 million gallons discharged to the canal during the irrigation season. Infiltration pond size would be approximately 35 acres.

Discharge to storage reservoirs would involve construction of sealed reservoirs near the treatment plant site. The storage system would consist of several smaller storage cells to afford operational flexibility and easier management of the system. Effluent stored in winter would be discharged to the canal during the next irrigation season at a constant rate sufficient to empty all lagoons by the end of the irrigation season. The delivery system would consist of a forcemain and effluent pumping station. Although some evaporation would occur from the storage reservoirs, effluent flows to the canal would range from 15 to 20 cfs, depending on the month and the rate of pumping from storage.

No-Action Alternative

The EPA regulations for preparation of an EIS require that a "no action" alternative also be evaluated and compared to the alternatives of effluent disposal. The no-action alternative for the City of Bend would entail continuation of the existing wastewater treatment and disposal systems described in Chapter 3. These are discharge of secondarily treated effluent from the existing treatment plant through a lava tube and discharge of inadequately treated wastes to the subsurface from over 6,000 individual disposal wells.

Chapter 5

Legal, Policy and Institutional Constraints

Chapter 5

LEGAL, POLICY AND INSTITUTIONAL CONSTRAINTS

This section provides a checklist of laws and regulations of various governmental agencies that have either regulatory or planning responsibility affecting implementation of proposed methods of effluent disposal. Those laws or policies which may act as constraints or guidelines at the federal, state, and local level for wastewater disposal in Bend are described.

Environmental Requirements (General)

The following regulations govern preparation of EISs:

National Environmental Policy Act

The National Environmental Policy Act of 1969 (NEPA) establishes policy regarding environmental quality. NEPA requires that all agencies of the federal government prepare detailed EISs on proposals for projects that may significantly affect the quality of the human environment. NEPA requires that agencies include in their decision-making process an appropriate and careful consideration of all environmental aspects of proposed actions, an explanation of potential environmental effects of proposed actions and their alternatives for public understanding, a discussion of ways to avoid or minimize adverse effects of proposed actions, and a discussion of how to restore and enhance environmental quality. The Act is implemented through the Council on Environmental Quality (CEQ).

Council on Environmental Quality (CEQ)

The CEQ is responsible for coordinating development of the impact statement process. Their published regulations and guidelines (40 CFR 6) apply to the obligation of all federal agencies under Section 102(2)(c) of NEPA. Final regulations are in the Federal Register, November 29, 1978. Under these guidelines each federal agency is required to adopt procedures for the implementation of the Act and CEQ guidelines. The EPA has proposed rules for implementing procedures on NEPA in the Federal Register, June 18, 1979.

EPA Cost-Effectiveness Analysis Guidelines

The EPA *Cost-Effectiveness Analysis Guidelines* (1974) provide a uniform method for computing and comparing the costs of wastewater treatment alternatives. The guidelines delineate the planning period over which the alternatives should be evaluated, the elements of cost that should be included, the interest rate that must be used, guidance on the service life of various types of facilities, and the salvage value that should be used for proposed projects.

Cultural Resources and Land Use Constraints

Because effluent disposal facilities will occur in part or wholly on federal land, the following rules and regulations governing preservation of cultural resources and use of federal land are applicable.

American Antiquities Act of 1906

This Act establishes protection over any "historical or prehistoric ruin or monument, or any object of antiquity situated on government lands . . ." A permit is required for their removal.

National Historic Preservation Act of 1966

This Act authorizes the Secretary of the Interior to expand and maintain a *National Register* and establish an advisory council given the responsibility to comment on the effect of federal undertakings on *National Register* properties.

National Environmental Policy Act

Title I, Section 101(b) of NEPA charges the federal government with "the continuing responsibility . . . to use all practicable means . . . to preserve important historic, cultural and natural aspects of our national heritage . . ."

Executive Order 11593

Executive Order 11593 (1971) entitled *Protection and Enhancement of the Cultural Environment* directs federal agencies to survey all lands and nominate properties to the *National Register*.

Recreation and Public Purposes Act of 1926

This Act authorizes the Secretary of the Interior, under specified conditions, to sell or lease National Resource Lands (public domain) to state and local governments for public and quasi-public purposes. Relevant provisions of the Act follow:

1. A limit to 6,400 acres exists on acreage that can be leased or purchased annually by political subdivisions of the state.
2. The BLM may dispose of no more land than is reasonably necessary for efficient operation of the projects described in the development plan submitted by an applicant.
3. The BLM must conduct a field examination and other investigations to gather information and data on the environmental considerations and proper classification of the land proposed for disposal. Public meetings must be held for any disposal over 640 acres.

Federal Land Policy and Management Act of 1976

Title IV, Section 402 (grazing leases and permits) states:

> "Whenever a permit or lease for grazing domestic livestock is canceled in whole or in part, in order to devote the lands covered by the permit or lease to another public purpose, including disposal, the permittee or lesser (sic) shall receive from the United States a reasonable compensation for the adjusted value . . . of his interest in authorized permanent improvements placed or constructed by the permittee or lessee on lands covered by such permit or lease . . . Except in cases of emergency, no permit or lease shall be canceled under this subsection without two years' prior notice."

The North Unit Main Canal is owned by the Bureau of Reclamation and operated by the North Unit Irrigation District. Under the following contract, there are stipulations governing operation of the canal system.

Amendatory Repayment Contract - U. S. Department of the Interior, Bureau of Reclamation, February 13, 1954

As interpreted by the Bureau of Reclamation, Article 29(b) implies that the District and the Bureau have the right to run water in the North Unit Main Canal system only during the irrigation season (Williams, pers. comm.).

Several effluent disposal alternatives, if chosen, would be constructed on BLM land in or near Site E, which is located directly north of the Bend Airport. The airport, which serves primarily propellor aircraft and some private turbo jets, is planned for expansion. The following Federal Aviation Administration (FAA) Regulations are applicable to the location, in relation to airports, of effluent disposal facilities involving use of open water areas.

Federal Aviation Administration Order 5200.5

> "5. CRITERIA. Sanitary landfills [or any other structure that attracts bird life (pers. comm. Ossenkop]), will be considered as an incompatible use if located within areas established for the airport through the application of the following criteria:
>
> a. Landfills located within 10,000 feet of any runway used or planned to be used by turbojet aircraft ..."

Water Pollution Control

The following federal and state laws governing water pollution control are applicable to all alternatives of effluent disposal.

Federal Water Pollution Control Act Amendments of 1972 and 1977

This Act establishes a national goal to eliminate the discharge of pollutants into navigable waters by 1985 and an interim goal of water quality which provides for the protection and propagation of fish and wildlife and provides for recreation in and on the water by July 1, 1983. National policies established by the Act call for federal assistance for construction of publicly-owned waste treatment works and preparation and implementation of area-wide waste treatment managment planning processes by each state. The EPA is designated as the administrator of the Act.

Under Section 102(a) of the Federal Water Pollution Control Act the EPA, in cooperation with state and local agencies, is responsible for developing . . .

> " . . . comprehensive programs for preventing, reducing, or eliminating the pollution of the navigable waters and ground waters and improving the sanitary condition of surface and underground waters. In development of such comprehensive programs due regard shall be given to the improvements which are necessary to conserve such waters for the protection and propagation of fish and aquatic life and wildlife, recreational purposes, and the withdrawal of such waters for public water supply, agricultural, industrial, and other purposes."

Safe Drinking Water Act

The Safe Drinking Water Act of 1974 (Public Law 93-523) directs the EPA to establish minimum national drinking water standards. These standards set limits on levels of specific contaminants in public water systems which, in the judgement of the EPA, may have an adverse effect on the health of persons.

The EPA has established maximum contaminant levels for various inorganic and organic chemicals, bacteria, radioactivity and turbidity (Appendix 3).

Under Part C of the Act, entitled Protection of Underground Sources of Drinking Water, the EPA has developed regulations governing underground injection of wastes (Section 1421). Section 1422 of the Act requires implementation of an underground injection control (UIC) program, which meets the requirements of regulations in effect under Section 1421, in states which, in the judgement of the EPA, need a UIC program to assure that underground injection will not endanger drinking water sources. The State of Oregon has recently been included on the list of states needing UIC programs (Federal Register, June 19, 1979) and therefore must develop a program meeting EPA requirements. The EPA has proposed regulations for UIC programs (Federal Register, April 20 and June 14, 1979). Under these proposed regulations, subsurface disposal via drill holes, as described in Chapter 4, would potentially be classified as a Class V well which includes municipal effluent disposal wells that discharge wastes above all underground sources of drinking water (Sceva, pers. comm.). A particular Class V well would be subject to regulation if it could be proven that the waste discharge was presenting a significant risk to the health of persons.

Water Supply Systems - Oregon Revised Statutes 448.205 to 448.325

Under these statutes the Oregon State Health Division has jurisdiction over all domestic water supply sources and community and public water supply systems. The division is in charge of examining water sources "periodically to ascertain whether the sources are adapted for use as water supplies for drinking and other household uses, or are in a condition likely to cause a public health hazard."

The division is required to prescribe minimum standards for the biological, chemical, radiological and physical quality of water supplied for water supply systems. State water quality standards are given in Appendix 4.

Water Pollution Control - Oregon Revised Statutes 468.700 to 468.775

Authority over water pollution control is given to the Oregon Department of Environmental Quality (DEQ) and Environmental Quality Commission under these statutes. The commission by rule may establish effluent limitations as defined in Section 502 of the Federal Water Pollution Control Act and other minimum regulations for disposal of wastes. The commission may also establish standards of water quality and purity for all river basins in the state.

Groundwater Act of 1955 - Oregon Revised Statutes 537.505 to 537.795

This Act directs the State Water Resources Department in conjunction with other agencies to assure "adequate and safe supplies of groundwater for human consumption . . . and prevent or control within practicable limits the impairment of natural quality of groundwater by pollution . . ."

Construction and Use of Waste Disposal Wells - Oregon Administrative Rules 340-44-005 to 340-44-045

In 1969 the State of Oregon adopted regulations designed to restrict, regulate or prohibit future construction and use of waste disposal wells in the state, particularly in lava terrain of central Oregon, because such practices constituted "a threat of serious, detrimental and irreversible pollution of valuable groundwater resources and a threat to public health . . ." Extracts of relevant sections appear in Appendix 5.

Oregon Revised Statute 690-62-025 adopted in 1977 by the State Water Resource Department states that "no well shall be used as a disposal pit for sewage, industrial waste, or other materials that could pollute the ground water supply."

Water Quality Standards and Effluent Disposal

Permit Requirements

Point source discharge of wastewater effluent to surface waters receives a Federal National Pollutant Discharge Elimination System (NPDES) permit which prescribes general and special conditions, such as allowable mixing zones and monitoring programs, governing the permitted discharge. All other methods of wastewater disposal not involving direct discharge to surface waters of the state come under the jurisdiction of the Oregon DEQ and are issued Water Pollution Control Facilities (WPCF) permits.

Surface Water Discharge

Deschutes River. Specific water quality standards have been adopted by the State Department of Environmental Quality for the Deschutes River basin to protect a variety of beneficial uses including domestic water supplies, irrigation, anadromous fish passage, rearing and spawning, recreation, and aesthetic quality. These standards are outlined in Appendix 6.

The Department of Environmental Quality has also established minimum design criteria for discharge of any waste from any new or modified treatment facility to waters of the Deschutes River basin, subject to the implementation program of Section 340-41-120 (requires issuance of a permit from the DEQ prior to discharge to public waters). Relevant criteria from Section 340-41-575 are also included in Appendix 6.

North Unit Main Canal. The North Unit Irrigation District NPDES waste discharge permit was revoked in March of 1978 (Appendix 7). The Clean Water Act of 1977, which amended the Federal Water Pollution Control Act, removed irrigation return flows from the point source pollution category and identified them as nonpoint source pollutants. Therefore, a permit is no longer required for the District's irrigation return flow.

Minimum design criteria (OAR 340-41-575) for waste discharge to the North Unit Main Canal would be 20 mg/l BOD and SS on an interim basis and 10 mg/l BOD and SS for long-term disposal (see DEQ letter, Appendix 8). ORS 449.550-449.565 (Deschutes River Pollution Abatement) prohibiting discharge of sewage effluent to irrigation canals in the Deschutes Basin was repealed in 1973.

Subsurface Discharge

Specific regulations regarding the quality of effluent discharged to lava tubes or drill holes are contained in WPCF permits issued by the DEQ. Current limitations on subsurface water disposal contained in the City of Bend WPCF permit (Appendix 9) are:

> "Prior to disposal of the waste water it shall receive at least the following treatment:
>
> a. Monthly average effluent flow shall not exceed 3785 m^3/d (1.0 MGD).
>
> b. BOD and TSS shall not exceed a monthly average of 20 mg/l or 76 kg/day (166.8 lb/day); weekly average of 30 mg/l or 113 kg/day (250 lb/day); and a daily maximum of 170 kg (375 lb).
>
> c. Effluent discharged to the sink hole shall receive disinfection sufficient to reduce fecal coliform bacteria to a monthly average of 200 per 100 ml or a weekly average of no more than 400 per 100 ml.
>
> d. The effluent pH shall be within the range 6.0-9.0."

Land Application by Spray Irrigation

Reuse of treated effluent is encouraged by both state and federal agencies. Section 201 (d) of the Federal Water Pollution Control Act Amendments states "the Administrator (EPA) shall encourage waste treatment management which results in the construction of revenue-producing facilities providing for ... the recycling of potential sewage pollutants through the production of agriculture, silviculture, or aquaculture products...". In addition, the EPA Policy on Land Treatment of Municipal Wastewater (D. Costle, letter to regional administrators, October 3, 1977) states that "particular attention should be given to wastewater treatment processes which renovate and reuse wastewater as well as recycle the organic matter and nutrients in a beneficial manner". Chapter 340-41-026 of the Oregon Administrative Rules states that it is the policy of the State of Oregon to give highest priority to alternatives of waste disposal which utilize reuse or disposal with no discharge to public waters.

The DEQ has prepared a proposed statewide policy for land irrigation and disposal of treated sewage effluent. These standards were adopted to act as guides in reviewing proposals for such use and disposal. Excerpts of relevant sections follow:

"IV. Application in Areas Where Public Contact is Restricted

1. Surface or spray irrigation of crops not for human consumption.
   Treated sewage effluent used for either surface or spray irrigation of alfalfa, stubble land, timber land, grass seed crops or other types of fodder crops shall at all times be an adequately disinfected secondary effluent. The sewage effluent shall be considered adequately disinfected if the average coliform bacteria count does not exceed 1,000 per 100 milliliters with not more than 20% of the samples exceeding 2,500 per 100 milliliters.

V. Degree of Treatment Required

2. Any sewage treatment plan where it is desired or intended to produce treated sewage effluent for the purpose of land irrigation under Section IV-1 above, must at all times during irrigation:

   A. Produce an effluent where the:

      (1) Biochemical oxygen demand does not exceed 30 mg/l.

      (2) Suspended solids do not exceed 30 mg/l.

   B. Provide an actual chlorine contact time as determined by dye test of at least 60 minutes at average design flow after thorough mixing.

   C. Provide a chlorine residual of at least 2.0 mg/l.

VI. Sampling, Testing, and Reporting

1. Land irrigation.
   All tests required by the waste discharge permit shall be conducted; and during the period when treated sewage effluent is being used for land irrigation, effluent samples for bacteriological analyses shall be collected at least three times weekly on alternate days of the week and shall be analyzed using an approved laboratory method for coliform bacteria count."

Additional and more restrictive regulations on spray irrigation for the City of Bend are contained in the current WPCF permit.

Sound irrigation practices must be followed to prevent:

"a. Prolonged ponding of waste on the ground surface;

b. Surface runoff or subsurface drainage through drainage tile;

c. The creation of odors, fly and mosquito breeding and other nuisance conditions; and

d. The overloading of land with nutrients or organics.

Unless approved otherwise in writing by the Department, a deep-rooted, permanent grass cover shall be maintained on the land disposal area at all times and periodically cut to maintain it in the growth cycle to insure maximum infiltration and evapo-transpiration rate during the disposal season."

Effluent must receive at least the following treatment:

"a. BOD and TSS shall not exceed a monthly average of 20 mg/l or 76 kg/day (166.8 lb/day); weekly average of 30 mg/l or 113 kg/day (250 lb/day); and a daily maximum of 170 kg (375 lb).

b. Effluent disposed of on land shall receive disinfection sufficient to reduce fecal coliform bacteria to a monthly average of no more than 20 per 100 ml. In no case shall the chlorine residual be permitted to drop below 1.0 mg/l.

c. The effluent pH shall be within the range 6.0-9.0".

Chapter 5

Effects of the Alternatives on Environmental Resources

Chapter 6

EFFECTS OF THE ALTERNATIVES ON ENVIRONMENTAL RESOURCES

Introduction

Central to the evaluation of viable wastewater disposal alternatives are the environmental impacts that result. In this chapter, both the beneficial and adverse impacts are identified and evaluated. Mitigation measures for adverse impacts are also discussed with primary attention given to those resources most evidently affected by the proposed actions.

Short-Term Impacts

Short-term impacts, as the name implies, have a short but finite period of impact, usually from the start until completion of project construction. Such impacts usually can be effectively mitigated. Common short-term impacts and their mitigation measures are presented in Table 6-1. Most of the short-term impacts presented are considered to be relatively minor or moderate in effect. A discussion of those short-term impacts considered to be most significant follows.

Major adverse short-term impacts would be associated with land application by spray irrigation. Construction of a spray disposal system would initially require conversion of 800 acres of native vegetation on Site E to cover crops such as fescue, orchard grass and meadow foxtail. An additional 550 acres on Site F would be converted for spray irrigation of effluent as the treatment plant is expanded to a capacity of 6 mgd.

A temporary loss of vegetation of this magnitude could significantly increase soil erosion. Soils in the Bend area are finely textured and when exposed are subject to severe erosion primarily by wind. Water erosion on Sites E and F would be minimal due to low rainfall and gentle slopes.

During construction of the spray disposal system, wind erosion of soils could be controlled by sprinkling water or wetting chemicals on the soil surface.

Table 6-1

SHORT-TERM IMPACTS
BEND EFFLUENT DISPOSAL ALTERNATIVES

The direct short-term impacts of this project are related to construction activities. Many are relatively minor in effect and magnitude and in most cases the adverse impact can be effectively mitigated. The impacts considered, our judgement of the relative level of effect and mitigation measures are given in the following matrix.

	Disposal Alternatives[2]							
	1						No	Recommended Mitigation
Short-term Impacts[1]	a	b	2	3	4	5	Action	Measures
Temporary loss of vegetation	1	2	1	2	3	2	0	Replant after construction or encourage regrowth of natural vegetation. Vegetation adjacent to pipelines should be flagged or fenced to keep vegetation destruction to a minimum.
Disruption to wildlife	1	2	1	2	2	1	0	Vegetation removal should occur during late summer or fall when nesting birds are not present.
Water quality degradation	1	1	2	1	1	2	0	Construction activities in streams or canals should be limited to low flow or no flow periods. Care should be taken not to discharge petroleum or other pollutants into streams.
Increased turbidity disturbance to fish life	1	0	2	0	0	1	0	Constuction should occur during period of lowest flow and when fish populations would be least affected.
Increased potential soil erosion and dust	1	3	2	3	3	2	0	Soil should be wetted down during construction. After construction exposed soil areas should be reseeded with native species or cover crops as soon as possible.

Short-term Impacts[1]	Disposal Alternatives[2]							Recommended Mitigation Measures
	1						No Action	
	a	b	2	3	4	5		
Construction-related traffic	1	2	2	2	2	2	0	Construction should occur, if possible, during the fall period when traffic volumes are lower.
Disruption of through and local traffic	0	0	2	0	0	1	0	Barricades and flagmen should be posted as necessary to guide traffic through construction zones. Residents in area should be notified as to location, nature, and duration of construction.
Safety hazards	1	1	2	1	1	1	0	All open trenches should be covered or fenced at the end of each work day. All construction equipment should be secured against unauthorized use.
Aerial pollutants	1	2	2	2	2	2	0	All vehicles and equipment should be fitted with appropriate pollution control devices that are properly maintained. (Burning of vegetation should be confined to periods of favorable meteorological conditions).
Visual impact of construction	1	1	2	1	1	1	0	Equipment should be stored in a designated area. All litter should be removed.
Spoil disposal	1	2	2	3	2	2	0	Wherever possible, disposal of spoil material from pipeline routes or other construction areas should be coordinated with other ongoing projects needing fill material.

Short-term Impacts[1]	Disposal Alternatives[2]							Recommended Mitigation Measures
	1						No Action	
	a	b	2	3	4	5		
Stockpiling and storage of spoil	1	2	2	3	2	2	0	All spoil material not needed for backfilling should be removed from pipeline routes or construction areas or spread over the surface and reseeded if possible.
Increased noise	1	2	2	2	2	2	0	All equipment should have mufflers, properly installed and maintained. Construction activities should be limited to daylight hours.
Employment	+	+	+	+	+	+	0	None necessary.
Economic activity	+	+	+	+	+	+	0	None necessary.

[1] Degree of Impact:

0 No change from present
1 Minor adverse impact
2 Moderate adverse impact
3 Major adverse impact
+ Beneficial impact

[2] Alternatives:

1 Subsurface Discharge: a) drill hole; b) infiltration
2 Discharge to the Deschutes River
3 Discharge to sealed evapotranspiration ponds (including peak flow and cold season use of infiltration basins)
4 Land application by spray irrigation
5 Discharge to the North Unit Main Canal (including options for winter discharge)

For storage of effluent whenever spraying is not possible, four 100-acre-foot reservoirs would be constructed on Site E. Reservoir construction would require removal of additional acres of native vegetation. Unless natural land depressions are used as reservoir sites, a significant amount of soil and rock would be excavated from the site and used in dike construction or removed. During construction, a significant amount of soil erosion by wind could occur. Those techniques mentioned above for controlling soil erosion and dust could be utilized here.

Construction of infiltration and sealed evapotranspiration pond alternatives would require removal of 85 and 1,305 acres of native vegetation, respectively. Construction operations would require extensive soil excavation and rock removal where natural land depressions are not used. During this time, loss of vegetation and soil disturbance could result in severe wind erosion of the remaining soil. Mitigation measures mentioned above for construction of a spray irrigation system would also aid in alleviating soil erosion problems during construction of evapotranspiration and/or infiltration ponds.

Primary and Secondary Long-Term Impacts

Primary impacts result directly from the construction, location and/or operation of advanced wastewater treatment (AWT) and effluent disposal facilities. These impacts tend to be on or near a facilities site or pipeline route or in the area of effluent disposal. Secondary impacts refer to induced effects of the project. These impacts may occur in all the areas in which primary project impacts are anticipated such as land use, economics, and the natural environment. They are the outcome of changes in the pattern of land and resource use for which the project can be seen as the sole or contributing cause. Secondary impacts are indirect in nature and, therefore, are generally more difficult to identify and quantify than are primary impacts. Primary and secondary long-term impacts generally remain in force for the life of the project (20 years), or longer.

The following section will address those primary and secondary long-term environmental impacts associated with alternative methods of effluent disposal and AWT treatment as well as those associated with the no-action alternative. Impacts will be discussed by resource categories such as surface water, groundwater, and fisheries. Any additional information about these resources, deemed necessary to discussing impacts, will be included under the appropriate resource category. Impacts associated with construction of the new wastewater treatment facility on Site E are similar for all effluent disposal alternatives considered and were evaluated in the EPA Negative Declaration issued in April 1978.

Reliability

Wastewater Treatment Plant. Central to the discussion of impacts of all disposal alternatives is the reliability of the future treatment facility in meeting secondary treatment standards. A recent EPA report indicated that approximately 55 percent of the nation's treatment facilities did not meet secondary treatment standards as defined by the EPA. In a separate report prepared for the EPA, 30 treatment plants were evaluated in detail with the following results:

- 23 percent met secondary treatment standards
- 54 percent did not meet secondary treatment standards because of operation and maintenance deficiencies
- 23 percent did not meet secondary treatment standards because of design deficiencies

Therefore, although biological secondary treatment is a common and well established treatment process, many problems are prevalent which result in below-standard effluent quality.

Activated sludge treatment systems are not difficult to operate, but they do require that at least the plant superintendent be a licensed operator who has had several years training on activated sludge plants. There are many methods that have been used successfully to operate activated sludge plants; however, descriptions of these are beyond the scope of this EIS. Based on the same 30-plant evaluation, the top ten reasons for not meeting standards were caused by the following: the first three were operational and of the next seven, six were caused by design deficiencies. The proper and efficient operation of the activated sludge plant is critical to the effectiveness of the effluent filtration process and subsequent chlorination process.

Therefore, in evaluating the environmental impacts of each disposal alternative the possibility of treatment plant failure will enter into these analyses. However, it will be assumed that the future treatment plant will meet secondary treatment standards most of the time.

Groundwater

Groundwater resources of the Bend area have been explored to only a limited extent by well development and use, and by professional investigators. Therefore, groundwater reservoir characteristics and dynamics have had to be inferred to a large degree. Drilling of new wells in recent years has added to the understanding of local groundwater. Detailed studies of the geology and groundwater below Site E have recently been completed (BECON, preliminary draft, September 1979). Final results of these studies, however, are not yet available.

Nevertheless, the state of knowledge in the overall region is adequate to allow a general assessment of conditions and to at least visualize the range of potential hydrogeologic occurrence beneath and adjacent to the project site. Whereas probable site groundwater conditions can be projected from data in other localities, recently completed site explorations will aid further in determining actual conditions and how possible disposal plans would affect the groundwater environment.

Hydrogeology. Most of the Bend project site area is underlain by basaltic lava flows to usual depths of 100 to 150 feet. These rocks, the so-called rimrock lavas, are characteristically jointed and fractured and contain occasional lava tubes, or caves. Consequently, they are substantially permeable and capable of transmitting fluids readily. It is into this zone that private septic tanks, as well as the City of Bend treatment plant, discharge sewage effluent.

Beneath this unit the Deschutes formation (formerly labelled the Madras formation) extends to depths of at least 600 to 700 feet. This formation is composed primarily of sedimentary materials, including sandstone, conglomerate, ash, cinders, sand and gravel and some clay. Lava flows are commonly interspersed with the sediments. Most area wells tap a deep aquifer zone and water table in the lower portion of this sequence at depths of 500 to 600 feet. This aquifer is not prolific and well yields are commonly limited to 2 to 10 gallons per minute. Weak-perched water bodies are occasionally encountered by wells at shallower depths which furnish small amounts of water in places. But frequently no usable amounts of groundwater are found above the regional water table. A few deep wells have been reported as dry holes.

A still deeper aquifer exists below this general area, tapped by several wells. Although very little data are available, it is believed to be of widespread regional extent and the principal groundwater resource in the region. The best indication of the aquifer is the recent U. S. Forest Service well at the Bend Pine Nursery, some 2 miles southwest of the project site boundary and about 3 miles from the new treatment plant locality. This well encountered an apparent weak-perched water zone around 500 feet. An aquifer zone with an estimated 100 gpm productivity potential was penetrated at an approximate depth of 943 feet under a small amount of artesian head. Then at 980 feet the well tapped a prolific aquifer, consisting of fine gravelly sand under a head of almost 300 feet. The completed well, open to both of these lower zones, tested at 1,500 gpm with less than a foot of drawdown and is now operational at a yield of 1,000 gpm. Static water level in the well was reported at a depth of 702 feet.

This deep aquifer may directly overlie the Columbia River basalt sequence, comprising either an interformational unit, or possibly the lowermost member of the Deschutes formation. Several other wells north and northeast of Bend exceed 700 feet in depth; however, they do not penetrate this deeper highly productive zone.

Several miles away, the two City of Bend supply wells encountered large aquifer sources at depths in the range of 700 to about 850 feet. Individual well production capacity has been rated up to 2,000 gpm. The distance of this locality from the Forest Service nursery well makes direct correlation dubious. Nevertheless, this deep production zone is probably hydrologically correlative with that of the Forest Service well and extends throughout a very wide region.

Groundwater Occurrence and Movement. Essentially, groundwater occurrence here can be categorized as consisting of a deep regional aquifer, as previously recognized, random localized perched bodies above it, and a deeper, highly productive aquifer under considerable artesian head.

Perched zones are often found in cinder or sand beds, but also in lavas and sandstones as well. Individual bodies of this type are not usually extensive, occurring randomly and erratically. Perched water tables are ordinarily shallow, ranging from 20 to several hundred feet in depth. Where tapped by wells, productivity varies from perhaps 1/2 to several gallons per minute. Perched water tables may slope in any direction depending on local stratification and recharge buildup, which diverts groundwater accordingly. Where gradients permit, trapped water flows beyond the edge of the supporting barrier layer and thence follows a downward path to the next obstruction at a lower depth. Whereas the ultimate destination of water moving downward is theoretically the deep regional aquifer zone tapped by most wells, the variety of stratification and rock materials in the appreciable depth interval to be traversed make such a course devious. Transit times cannot be estimated at present. In some areas they could be relatively rapid, but rates are undoubtedly extremely slow in others.

The zone heretofore referred to as the regional aquifer has usually been encountered between depths of 600 and 700 feet. The piezometric levels in such wells run 500 to 600 feet deep, often within 50 feet of the well bottom. In some cases, there is a minor rise in water level after the aquifer is first penetrated but such apparent artesian effects may be only localized.

Similar to perched bodies, this water is reported to occur in sands, gravels, lavas, pumice, sandstone, cinders and other materials. Although the best source available to most wells, productivity is low, seldom exceeding an adequate house supply; occasionally it is inadequate. Many wells are constructed with only surface casing, leaving almost the entire hole open. Well deepening is a common practice.

Despite large areas with no groundwater data, it is apparent that the regional piezometric slope is generally northward. However, local variations exist. In this regard, a large piezometric ridge is suggested from Bend northeastward through the western portion of the project site area. The western limb of the ridge underlies a reach of the North Unit Main Canal. Also, directly north of Bend the piezometric slope is locally eastward, forming a trough between this area and the aforementioned ridge. The ridge might be maintained by canal leakage, irrigation seepage, upstream river percolation, and/or city sewage disposal. The indicated movement north of Bend may be caused from river or irrigation seepage, or both.

The deeper artesian aquifer tapped by the Forest Service (and probably the Bend wells), is indicated to be an extensive groundwater system conveying very large amounts of water from southerly source areas northward. The water level in the Forest Service well stands at an elevation below water levels in regular deep wells, thus there is no upward movement into the mainsource aquifer zone. Similarly, there is probably no significant movement of water downward into this underlying artesian aquifer system in the general Bend project site area.

Recharge and Discharge. With the exception of the deep artesian zone, local groundwater bodies are maintained from waters which percolate from the surface in this region. Local annual precipitation averages 12 inches, probably insufficient to generate significant recharge to groundwater. Therefore, only in wetter years is percolation from precipitation probably of recharge importance. Streams lose portions of their flows to ground seepage in certain reaches. This is probably unimportant with regard to minor drainage in normal years. Deschutes River percolation is uncertain below Bend, but must contribute at least some to shallower zones. Excess irrigation water also percolates in most cases to add to groundwater supplies.

East and northeast of Bend, seepage losses from canals are indicated to constitute a substantial source of groundwater. It is estimated that about 11 percent of total flow in the North Unit Main Canal is lost to seepage between Bend and the Crooked River Canyon (Estes, pers. comm.). Consequently, this could mean an 8,000 to 10,000 acre-feet per year loss in the stretch within and upstream of the project site. Considering the other canals in this area, total canal losses could amount to several tens of thousands of acre-feet per year on the average going to recharge groundwater.

North Unit Main Canal losses do not maintain a localized percolation ridge discernible by available data. Data on 12 wells, located within 1/8 to 1/4 mile of the canal southwest of the project site, show that all but one water level was in the 500-foot range or deeper. The exception well had a level of 200 feet; however, a well a short distance away was dry. From this, it is concluded that canal seepage effects on groundwater are reflected broadly in the deeper tapped zone.

The injection of sewage effluent in and around Bend is large enough to be a significant recharge factor. The city sewage treatment plant discharges .5 million gallons per day of treated effluent to a lava tube. City effluent has been thus disposed of for many years. In addition, approximately 1/2 of the city's residents depend on septic tanks, which discharge practically all household water to porous lavas.

Recharge to the deep artesian aquifer occurs to the south, primarily from river and snowmelt percolation.

In the general Bend area groundwater is discharged through well pumpage and subsurface flow, basically in a northerly direction. There is one recently constructed well on Site E. The closest private wells to Site E are situated approximately 1½ miles west and 2 miles northwest of the new treatment plant. Thus, there is some groundwater discharge as well as subsurface outflow in this vicinity. Whether or not the main tapped aquifer zone is capable of transmitting large amounts of water laterally is somewhat questionable, considering the poor well productivity. In any case, local additions to this zone must move through the area as subsurface flow until entering the area of a well.

Groundwater Quality. Generally, groundwater is of excellent mineral quality. Previous sampling by federal and state agencies show that total dissolved solids range from about 65 to 225 mg/l; hardness is commonly between about 25 and 140 mg/l; and maximum chlorides are on the order of 15 mg/l. There are reports of problem iron content but this is not known to be a widespread condition. Except for the possible iron problem local Bend area groundwater is very suitable for domestic as well as irrigation purposes.

Available groundwater quality data generally show no important variations between wells or aquifer source. Partial analyses of water from the Forest Service well indicate it is similar to the average quality reported for other area groundwaters, except that total dissolved solids (240-290 mg/l) range higher than most. Most variations are caused by the occurrence of different rock materials which add additional mineral matter to migrating waters. Overall mineral content generally increases with distance downstream from the Bend area due to greater contact time with aquifer rock materials.

There are no data currently available on the quality of groundwater underlying the project site. However, mineral quality there should be similar to that to the west and southwest. Therefore, it is assumed that site groundwater, including perched water, if any, is of low mineral content and acceptable for all normal uses.

Impacts of Subsurface Disposal - Drill Holes. The potential for groundwater contamination is the major problem associated with effluent disposal to drill holes. Contamination can occur through one of several mechanisms as follows:

1. Direct emplacement into potable water zones;
2. Escape into potable aquifer by well-bore failure;
3. Upward migration from receiving zone along the outside of the casing;
4. Leakage through inadequate confining beds;
5. Leakage through confining beds due to unplanned hydraulic fracturing;
6. Leakage through abandoned wells;
7. Migration to potable water zone of the same aquifer.

Of these mechanisms, the first six have documented instances of occurrence, while the seventh mechanism is considered to be a probable occurrence in the future. There are certain other mechanisms that are specifically related to drill holes in the lava and sedimentary rock associated with the cracks and crevices in these formations. Wastes that find their way into these formations by whatever mechanism are dispersed to unknown degrees and eventually find their way to the groundwaters. An idealized plume of effluent travel in the regional aquifer from Site E is presented in Figure 6-1. If discharge is to a perched zone, the plume could travel in an entirely different direction.

There are basically two applicable mechanisms of attenuation which would reduce the contaminant concentration with time and distance traveled. The mechanisms are adsorption and other chemical reactions, and dispersion and dilution. The unknown conditions here make it difficult to predict the degree of contaminant attenuation. The mechanisms are briefly described below.

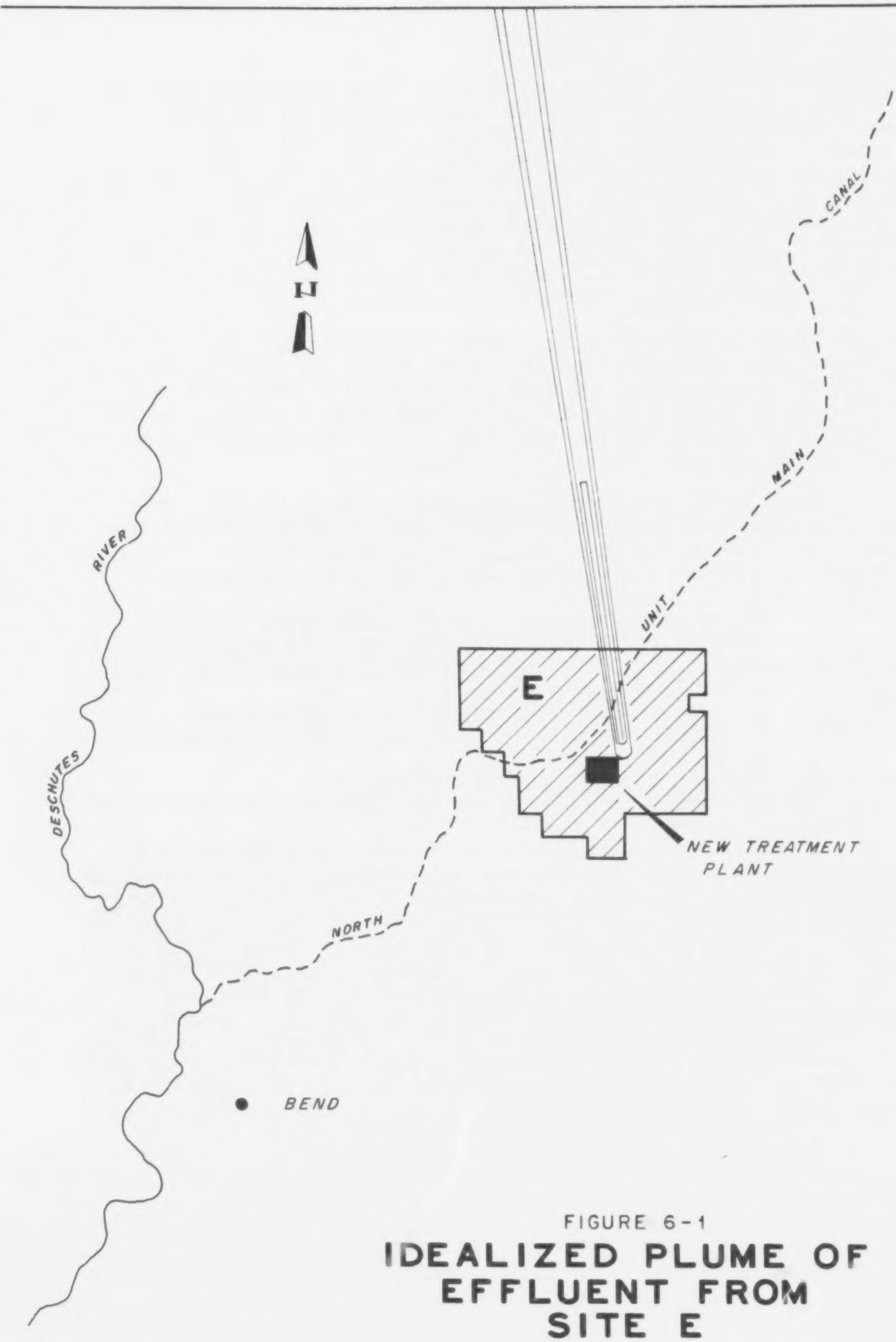

N
CANAL
MAIN
UNIT
NORTH
RIVER
DESCHUTES
E
NEW TREATMENT PLANT
BEND

FIGURE 6-1
IDEALIZED PLUME OF EFFLUENT FROM SITE E

Adsorption is the phenomenon whereby the surfaces of solids in contact with water are covered with a thin layer of molecules or ions taken up from the water and held tightly by physical or chemical forces. The more finely divided the soils, the greater is the surface area per unit volume and therefore the greater the capacity for adsorption.

Dispersion is the flow pattern of the contaminants through the ground profile. In general, the contaminated water moves to its destination by a definitive route and is not subject to dilution from the entire body of groundwater. An idealized system is shown in Figure 6-2. However, because groundwater systems seldom can be represented by the "ideal" situation, dilution of the contaminated water body probably takes place. Mechanical interactions between the natural groundwaters and contaminated waters result in water intermingling and therefore some dilution. Dispersion is affected by the inherent capacity of the aquifer to cause dispersion and also the velocity of groundwater movement.

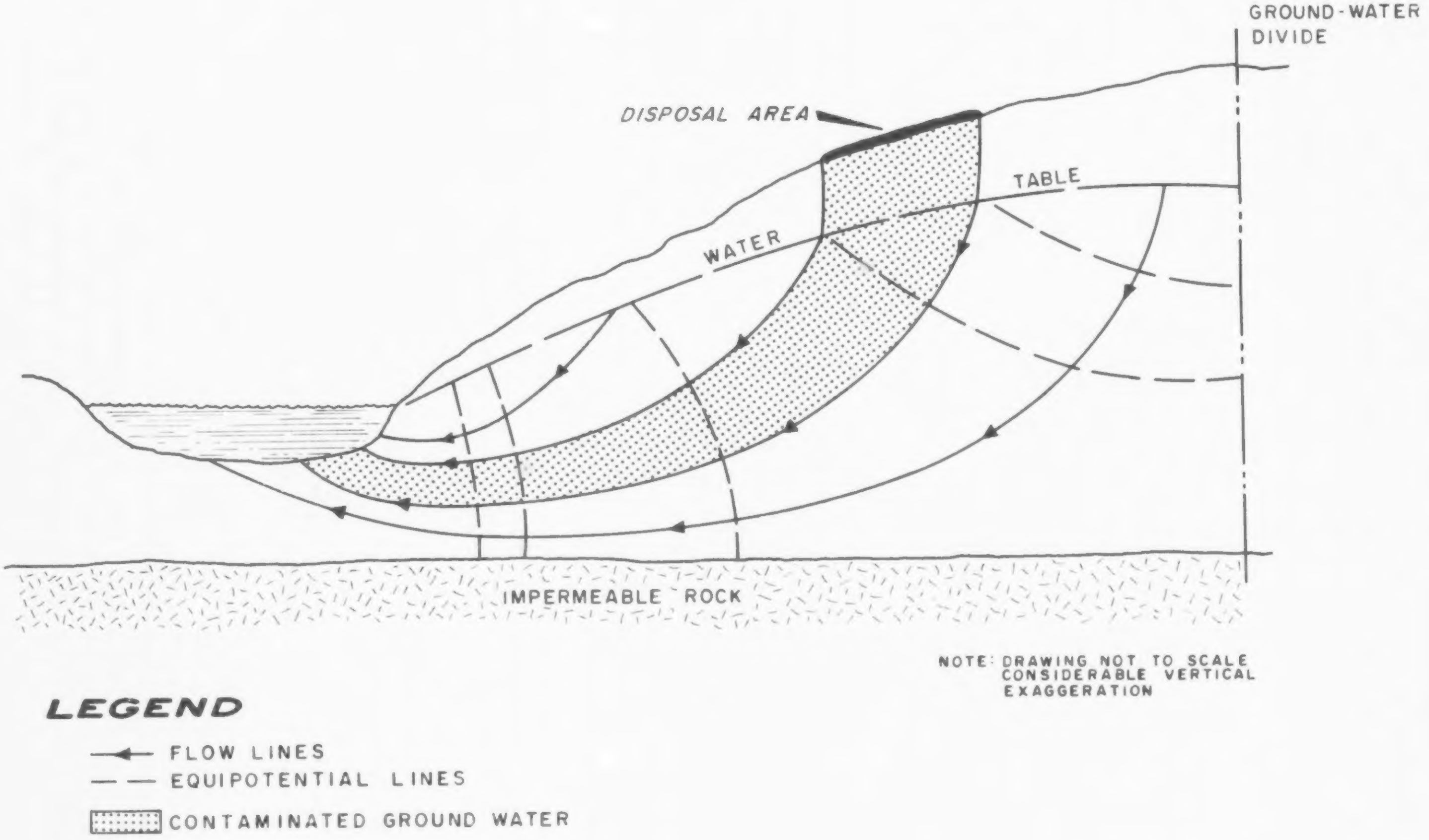
As mentioned previously, the City of Bend has for many years discharged sewage effluent to the ground. Such effluent has received secondary treatment in recent years; formerly, little or no treatment was given. Added to this, a large portion of the city's residences (half or more) dispose of liquid wastes through septic tank systems which discharge to shallow drill holes averaging 50 feet in depth. No groundwater effects of these public and private injections have been detected thus far, although no detailed special studies have been conducted.

This effluent first enters the fractured lavas overlying the Deschutes formation, some perhaps going into lava tubes or tunnels. By and large, it appears that it is successfully dispersed in the subsurface. However, it is not at all certain that as the quantities of local effluent increase, subsurface limits for purifying it are not being closely approached, particularly in the case of septic tank discharges. The close proximity of septic tank discharges to uncased water wells in the Bend area also may eventually lead to contamination of local water supplies as depicted in Figure 6-3.

Primary Impacts. Daily pollutant loadings for drill hole disposal are estimated to be 350 pounds BOD, 150 pounds suspended solids, 500 pounds nitrate and 250 pounds phosphorus. The primary consideration in defining impacts of this projected daily pollutant load on groundwater resources is that specific hydrogeological conditions beneath the project site are unavailable at this time. Thus, they must be inferred from conditions in neighboring areas. In view of variations from place

FIGURE 6-2

FLOW IN A WATER-TABLE AQUIFER

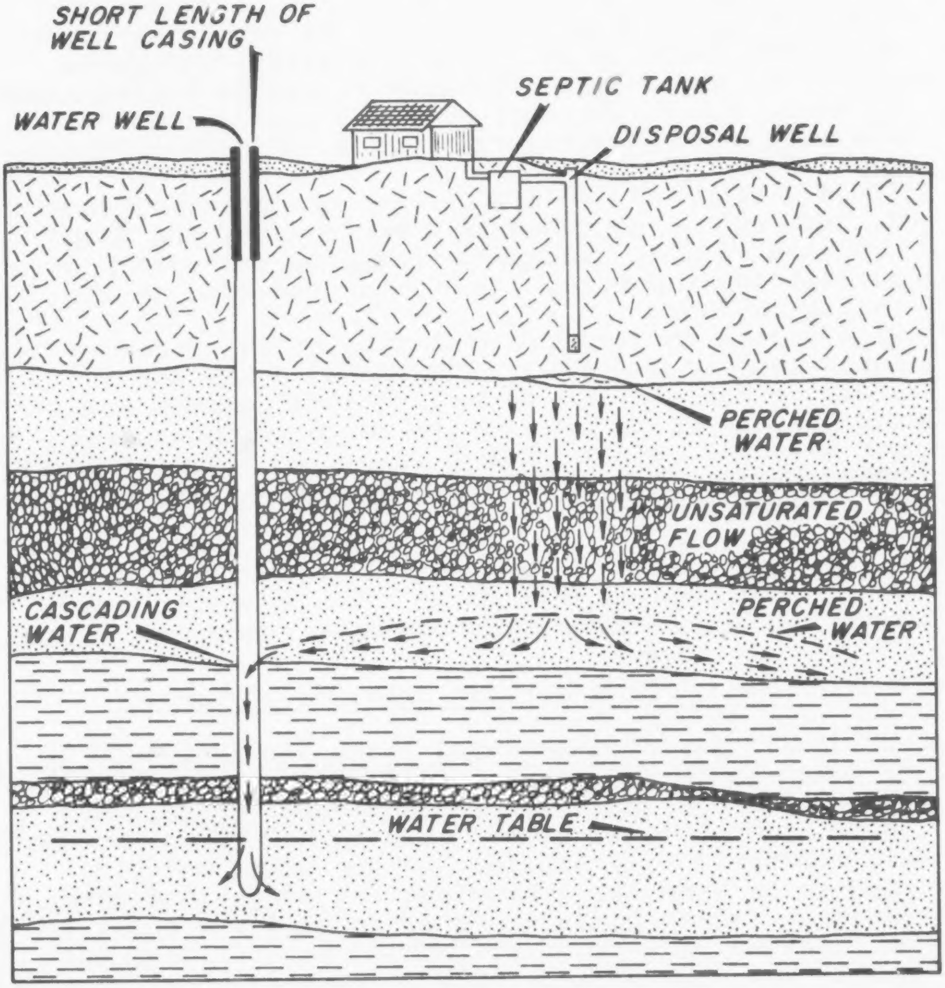

GROUND-WATER DIVIDE
DISPOSAL AREA
WATER
TABLE
IMPERMEABLE ROCK
LEGEND
FLOW LINES
EQUIPOTENTIAL LINES
CONTAMINATED GROUND WATER

NOTE: DRAWING NOT TO SCALE
CONSIDERABLE VERTICAL
EXAGGERATION

SOURCE: THE REPORT TO CONGRESS, WASTE DISPOSAL PRACTICES AND THEIR EFFECTS ON GROUNDWATER, JANUARY 1977

FIGURE 6-3

POTENTIAL MECHANISM FOR CONTAMINATION OF UNCASED WELL


SHORT LENGTH OF WELL CASING
WATER WELL
SEPTIC TANK
DISPOSAL WELL
PERCHED WATER
UNSATURATED FLOW
CASCADING WATER
PERCHED WATER
WATER TABLE

SOURCE: THE REPORT TO CONGRESS, WASTE DISPOSAL PRACTICES & THEIR EFFECTS ON GROUNDWATER, JANUARY 1977.

to place elsewhere, it is impossible to predict the occurrence, or nonoccurrence, of perched groundwater bodies and the nature and even existence of the deep regional aquifer zone tapped by many area wells. Furthermore, these conditions could well change markedly over the site area itself.

In addition, the apparently successful subsurface disposal of effluent at Bend is considerably removed from the site and may involve somewhat different subsurface conditions. Until conditions are shown to be truly comparable in either instance, the Bend experience cannot be directly related to project prospects.

Positive Considerations for Subsurface Disposal.

1. The indicated percolation processes could apply, in which any perched groundwater bodies receiving effluent would eventually spill, or otherwise drain, and there could be sufficient filtering sediments above the regional water table to assist purification.
2. Dilution within the deep regional aquifer could diminish any remaining vestiges of adverse effluent quality.
3. It is likely that no significant amount of effluent discharged to the subsurface would enter the deep artesian aquifer system, potentially the most productive and important groundwater resource in the entire region.
4. Significant development and utilization of new domestic supply wells on BLM lands to the north could be controlled. Under BLM's Management Framework Plan, public land to the north is designated for multiple use management (i.e., grazing, watershed protection, wildlife habitat management, etc.). No disposal of public lands for private housing development is planned (Paterno, pers. comm.).
5. An adequate monitoring program should detect any developing problem in time to allow remedies before major damage is done to groundwater resources.

Negative Considerations Against Subsurface Disposal.

1. Permeabilities of underlying lavas and sediments may be too high to provide the filtration-purification processes required. The closest drilling records indicate that most, if not all, harder rocks encountered are fractured or vesicular and the other materials tend to be granular. Previous investigations cite research in the Snake River Plain of Idaho involving percolation of wastewater through basalt, clay and rubble and suggest that some contamination of regional groundwater would probably be unavoidable (U. S. EPA, 1977).

2. Perched groundwater zones may exist beneath the site which do not spill laterally and/or leak-drain, as assumed for most Bend area conditions. Effluent discharged to the subsurface could thus build up to high levels which would reduce discharge rates. Although a remote possibility, considering the distance involved, uncased wells could act as conduits downward for such fluids (see Figure 6-3).
3. Should the disposal well(s) be cased through perched zones, it could involve losing much potential filtration benefits. Moreover, effluent discharged directly in or even near an aquifer is fundamentally undesirable in any case.
4. Subsurface disposal of effluent at the current treatment plant may not be a valid example for comparison of project site potential. Harmful effects could be accruing which will become troublesome in the future. It is possible that contamination exists at present, but goes unnoticed.
5. There is no guarantee of the local ability of the deep aquifer zone to remove this additional inflow efficiently, or that it even exists in the usual form at this location. Some well experience has found the aquifer to be tight and several dry holes are reported.

Prior to obtaining final results of recently completed exploration and testing of subsurface conditions on Site E, it is not possible to reasonably project what the effects would be on groundwater uses from discharge of project effluent into the ground. Whereas much will be learned from test drilling, particularly regarding optimum disposal well design, actual subsurface discharge tests would be needed, involving a simulated project operation, plus monitoring of groundwater in adjacent piezometers, to establish probable capabilities of this area to disperse fluids at the rate required. Purification of effluent could not be tested in advance.

Should drill hole disposal of effluent be pursued, it should be set up on an experimental basis, with the prospect that it will be interim only. Accordingly, other disposal procedures must be available for use in the event subsurface discharge provides unsatisfactory.

Secondary Impacts. Should water resources become contaminated by an ongoing disposal operation to the extent that existing domestic water users from wells or springs are prevented from utilizing their supply, such supply will remain polluted to that level, or worsen, as long as the offending disposal continues, and longer. Under such conditions, would-be domestic water users would also be deterred from using the same supply.

The deep regional aquifer commonly utilized in the region, and which is assumed subject to contamination, is characteristically inadequate for more than minimal irrigation supplies. Consequently, irrigation use does not appear to be a realistic alternative well use for affected households.

If the stated aquifer becomes unusable, replacement wells and any new wells would have to be drilled to the deep artesian zone.

Impacts of Subsurface Disposal - Infiltration. Daily pollutant loadings to infiltration ponds are estimated to be 1,500 pounds BOD, 1,500 pounds suspended solids, 1,000 pounds ammonia and 400 pounds phosphorus. Removal efficiencies for infiltration ponds should be greater than those for drill hole disposal because effluent would travel through approximately 3 feet of soil before entering the groundwater. Removal of BOD, suspended solids, viruses and bacteria has in recent studies been calculated to be greater than 98 percent in infiltration ponds. Other contaminants such as nitrates and phosphorus have shown removal efficiencies as high as 80-96 percent (Pound and Crites, 1973). Actual pollutant removal efficiencies for soils in the Bend area, however, are not known. Monitoring programs would provide needed information.

Impacts of Deschutes River Disposal. Deschutes River percolation to groundwater is uncertain below Bend, but is thought to contribute some water to shallower zones. The dilution of effluent discharged to the river in winter would be very great. Thus, the effects of winter discharge on groundwater would be insignificant. Summer discharge of effluent to the canal, however, would receive less dilution and could have some effect on shallow perched groundwater zones. The contamination risk would be less than that for subsurface disposal to drill holes because of the dilution effect of river water, some biological decontamination in the river environment and reduced effluent quantities received by groundwater zones.

Impacts of Evapotranspiration Ponds. Evapotranspiration ponds would be sealed with clay material and by natural processes, and canals would be sealed with cement to prevent seepage of effluent to the groundwater. Thus, there should be no impact on groundwater from these ponds. Impacts on groundwater from infiltration basins included in this alternative would be similar to those discussed under subsurface disposal-infiltration ponds. The potential for groundwater contamination in this case would be reduced because less than half of the effluent produced would be discharged to infiltration ponds.

Impacts of Land Application by Spray Irrigation. Although soils are thin in places over lava bedrock, they would supply an important element of effluent treatment at the outset of deep percolation. The proper crop will also remove much of the nutrient load. Percolation from the ground surface would give a longer filtration path than for subsurface disposal.

A large portion of the water applied would be consumptively used by the crop and evaporated from the adjacent soil. Consequently, only a minor portion of total waste discharge would be available to percolate below the root zone to groundwater. This amount has not been officially estimated yet, but, under proper management, probably on the order of 20 percent or less of applied effluent would so percolate in summer. Of course, the winter-time rate of crop consumptive use would be lower, but so would effluent discharge. However, for the year, it is reasonable to assume that less than half, and perhaps only 30 to 40 percent of plant effluent, would be excessive to crop evaporation demands and thus tend to percolate downward. Percolate would be diluted somewhat in winter by precipitation.

Dispersion of the discharge over the large specified area, and perhaps additional land, rather than concentrating it at only one or several point sinks, makes a vast difference in the subsurface ability to absorb, filter, and eventually transmit the added water from the area.

All factors considered, it is concluded that area groundwater resources would not be adversely affected by spray-irrigation disposal of plant effluent under a properly managed operation.

Impacts of North Unit Main Canal Disposal. As previously stated, available well data near the canal show only a deep water level in the 500-foot range. Seepage from the canal may be temporarily retained in one or more perched zones, but there is no evidence that any significant shallow water table is thus maintained. Consequently, canal seepage is assumed to percolate deeply to the regional groundwater zone utilized by most wells in the fashion previously described.

The dilution of effluent discharged to the canal in summer would be very great. Translated into quantities of effluent which might seep from the canal, the total is very small. Thus, the effects of summer effluent discharge into the canal or groundwater should be insignificant.

On the other hand, discharge to the canal in winter when it is empty would not be expected to proceed a great distance down the canal before entering the ground. BECON has estimated this distance to be approximately 8 miles (Design Definition Memorandum #10). This would involve some of the same elements as subsurface discharge with some of the same contamination risk. Therefore, subsurface conditions would have to be explored by test drilling and the operation monitored using somewhat similar though less stringent procedures. There would be some winter dilution of effluent from precipitation, which would mitigate effects to some extent.

Impacts of the No-Action Alternative. Adoption of the no-action alternative (discharge of secondarily-treated, chlorinated effluent from the present wastewater treatment plant to a lava tube and discharge of inadequately treated wastes to the subsurface from individual disposal wells) could eventually have an adverse effect on groundwater supplies in the Bend area. The potential for groundwater contamination would be greatest under this alternative because effluent entering the subsurface would receive minimal treatment. In addition, projected population growth in the City of Bend would magnify the potential for groundwater contamination. Because the present treatment plant has a capacity of 2 mgd, it would not be possible to connect residents now on septic tanks or new residents in the Bend area to the sewer system without expanding the treatment plant. This would result in the continuation of subsurface disposal of inadequately treated wastewater which, after 1980, would be in violation of OAR 340-44-045. This regulation prohibits the use of waste disposal wells after January 1 of that year unless approved and authorized by the DEQ.

Surface Waters - Deschutes River

The Deschutes River flows to the north through the study area. Beneficial uses of the river include recreation, fish rearing and spawning, irrigation and domestic uses. Four state parks are located on the river between the Bend diversion dam and Round Butte Dam. Lake Chinook is a popular recreation area for swimming, water skiing and fishing. Fishing use of this portion of the river in 1970 was estimated to be 6,300 angler days (Fies, pers. comm.).

Fifteen private domestic water diversions are located on the Deschutes River between the Bend diversion dam and Lake Chinook. All are located between the diversion dam and the town of Tumalo (Figure 6-4). In addition, 20 miles downstream from the diversion dam the City of Redmond utilizes river water in winter as an emergency backup source for two city wells. Deschutes River water has not been used for this purpose, however, for the last three years (Edwards, pers. comm.). The city's major water source in summer is the Pilot Butte Canal, which diverts Deschutes River water above the Bend diversion dam. City residents receive water that has gone through a process of coagulation, sedimentation and chlorination.

The City of Redmond also has developed plans to utilize Deschutes River water as a future year-round domestic supply because of current problems with canal water quality and well operation (Edwards, pers. comm.).

Impacts on Surface Water. For effluent discharge to the Deschutes River, the projected pollutant loadings from the treatment plant are as follows: BOD at 350 pounds per day; suspended solids at 150 pounds per day; ammonia-nitrogen at 1,000 pounds per day and phosphorus at 250 pounds per day. Based on the low flows anticipated during the winter months, a dilution ratio of approximately 14 to 1, based on estimated low flow conditions of 150 cfs, would result in a minimum of contaminant concentration increases. The quality of effluent discharged to the Deschutes River would meet all existing standards. There would be a small oxygen deficit which would not cause the dissolved oxygen concentrations to fall below 90 percent of saturation, which is the required minimum value.

These conditions, however, would be magnified substantially for discharge to the Deschutes River during the summer months, when the low flow conditions have been determined to be 15.5 cfs. The oxygen saturation would fall to approximately 85 percent of saturation, which is nominally below the 90 percent value required by state standards.

There should be no impact on Deschutes or Crooked Rivers water from subsurface disposal or land application of effluent. Deep groundwater recharge to streams is many miles northward in the Crooked River Canyon, primarily in the vicinity of Opal Springs. It is projected that no project contaminants would be measured at these recharge areas.

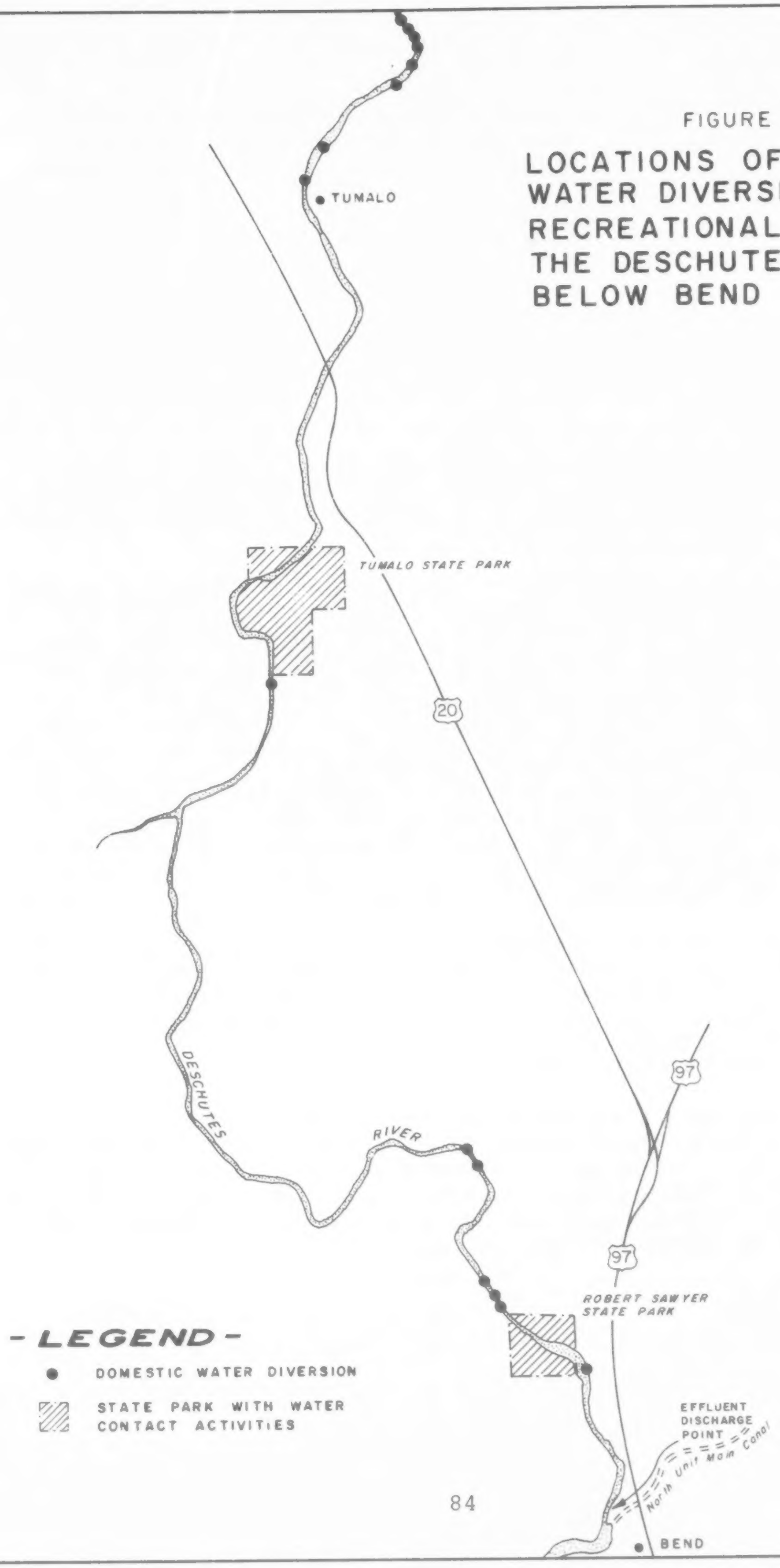

TUMALO
TUMALO STATE PARK
20
97
97
DESCHUTES
RIVER
ROBERT SAWYER STATE PARK
EFFLUENT DISCHARGE POINT
North Unit Main Canal
BEND
- LEGEND -
● DOMESTIC WATER DIVERSION
▨ STATE PARK WITH WATER CONTACT ACTIVITIES

FIGURE 6-4

LOCATIONS OF DOMESTIC WATER DIVERSIONS AND RECREATIONAL USE ON THE DESCHUTES RIVER BELOW BEND

Surface Waters - North Unit Main Canal System

The North Unit Main Canal, which is a Bureau of Reclamation project operated by the North Unit Irrigation District, is approximately 65 miles long with 235 miles of laterals. The canal system diverts water from the Deschutes River at Bend for agricultural and limited domestic use in Jefferson County. Crops grown using canal water include fresh vegetables, potatoes, garlic and peppermint. The Cities of Madras, Metolius and Culver utilize canal water for various purposes. In years of low precipitation water is also diverted from the Crooked River where the canal crosses the river canyon. Figure 6-5 shows the route of the North Unit Main Canal and the 58,000 acres of agricultural land served by the irrigation district.

Haystack Reservoir, at canal mile 40, acts as a regulating reservoir for the canal system to reduce operational waste. During the irrigation season water levels in the reservoir can fluctuate in excess of 1 foot per day. Morphometric data for Haystack Reservoir is given in Table 6-2. The reservoir is a recreational area for swimming, water skiing and fishing. An estimated 29,214 recreationists visited the reservoir in 1977 for water contact activities (Crooked River National Grassland, unpublished data). A private resort is located on the south side of the reservoir.

Flows in the North Unit Main Canal average approximately 700 cfs for 6 1/2 months of the year (mid April through October). The canal carries no flow for the remaining 5 1/2 months. During the irrigation season, significant water losses from the canal occur through seepage. As previously stated, these losses approximate 11 percent of canal flow between Bend and the Crooked River Canyon (Estes, pers. comm.). Excess canal water eventually returns to the Deschutes River via spillways at Willow, Mud Spring and Trout Creeks.

The sole user of canal water for domestic purposes is the City of Madras, which diverts approximately .5 cfs from the canal at mile 56 during the irrigation season to supplement three city wells. Canal water receives coagulation, sedimentation and chlorination treatment prior to use by city residents. The Cities of Metolius and Culver use canal water for vegetable production, lawns and yards.

Impacts on Surface Water. Daily pollutant loadings to the irrigation canal for BOD, suspended solids, ammonia, and phosphorus would be 350 pounds per day, 150 pounds per day, 1,000 pounds per day, and 250 pounds per day, respectively. These numbers are based on typical values from an activated sludge plant achieving a "10/10" (10 mg/l BOD and suspended

FIGURE 6-5

THE NORTH UNIT IRRIGATION DISTRICT CANAL & RESERVOIR SYSTEM

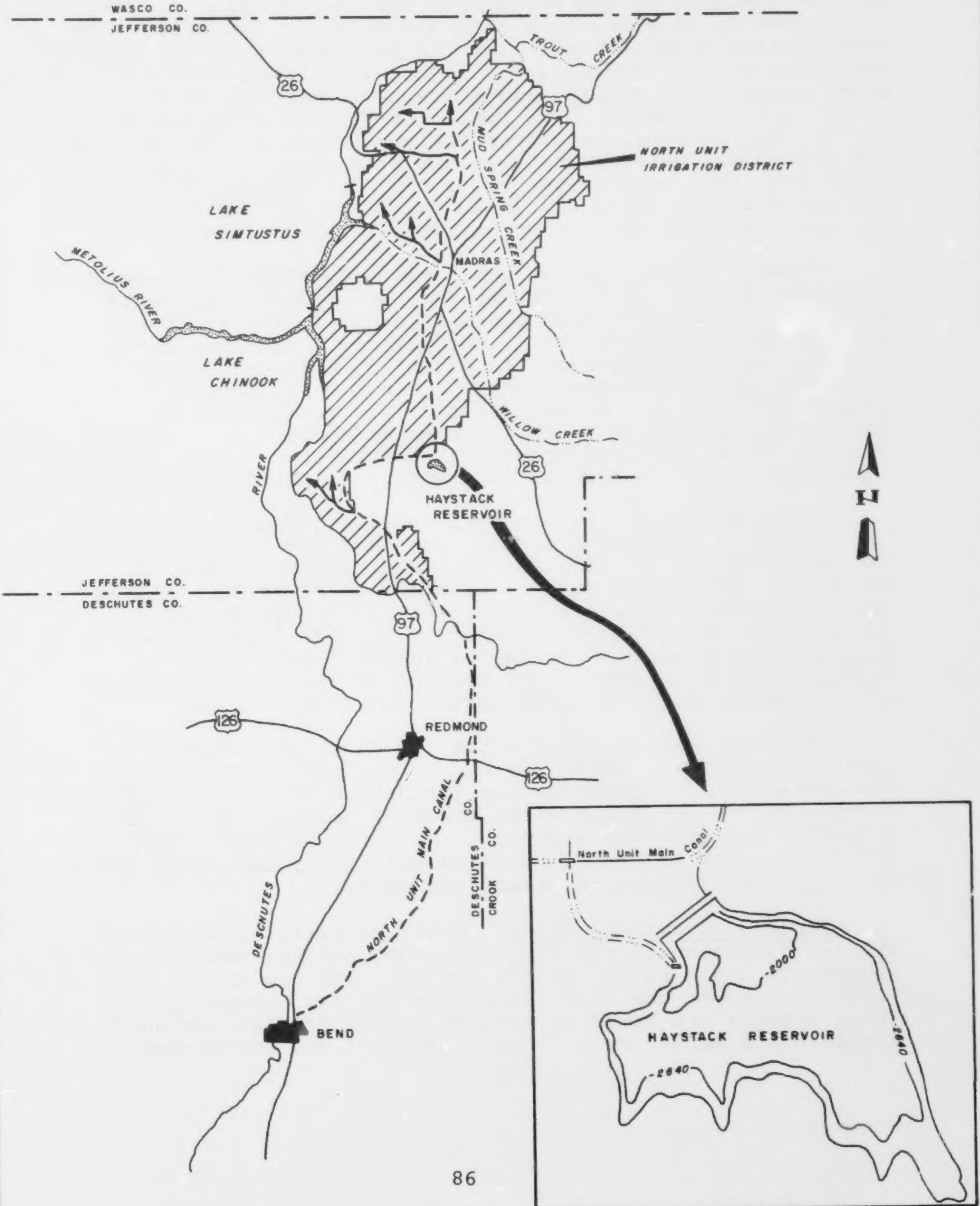

WASCO CO.
JEFFERSON CO.
TROUT CREEK
26
97
MUD SPRING CREEK
NORTH UNIT IRRIGATION DISTRICT
LAKE SIMTUSTUS
METOLIUS RIVER
MADRAS
LAKE CHINOOK
WILLOW CREEK
RIVER
26
HAYSTACK RESERVOIR
N
JEFFERSON CO.
DESCHUTES CO.
97
126
REDMOND
126
NORTH UNIT MAIN CANAL
CO.
DESCHUTES CO.
CROOK CO.
DESCHUTES
BEND
North Unit Main Canal
2000
HAYSTACK RESERVOIR
2640
2640

Table 6-2

MORPHOMETRIC DATA FOR HAYSTACK RESERVOIR

Morphometry	
Surface area	225 acres (105 Mm^2)
Volume (2,842 feet pool elevation)	5,650 acre-feet (8,690 Mm^3)
Mean depth	25 feet (7.65 meters)
Maximum depth	68.5 feet (20.9 meters)

M = million
m = meters

Source: U. S. Bureau of Reclamation, 1972.

solids) effluent quality. Based on the typical average flow in the North Unit Main Canal of 700 cfs, a dilution ratio of 77 to 1 would result at a 6 mgd flow rate. At low flows in the canal reported to be approximately 59 cfs within the last five years, the dilution ratio would be 6.5 to 1. The coliform count would be kept below 10 MPN/100 ml.

Eutrophication Potential. The lack of water quality data (from Storet, 1978) in the Deschutes River basin allows only a cursory analysis and a crude estimate of potential eutrophication problems in the North Unit Main Canal system. Deschutes River water at the Bend Diversion Dam is relatively soft with little buffer capacity (alkalinity - 30 mg/l as $CaCO_3$, total hardness - 20 mg/l as $CaCO_3$). The pH (7-8.3) and DO (86-109 percent saturation) values indicate little primary productivity problems. A marked productivity increase occurs west of Cove State Park (pH - 7.5-9.3; DO - 97-165 percent saturation) from input of Crooked River water, which is of poorer quality.

The North Unit Main Canal requires treatment with xylene to remove objectionable plant growths indicating an input of nutrients from the Deschutes and Crooked Rivers and from within the canal system. These plants interfere with flow as well as affecting aesthetics and water quality.

A detailed water quality analysis of the existing canal system is available in appendix form upon request.

Based on phosphorus as the controlling variable, results of the water quality analysis indicate that Haystack Reservoir would become eutrophic (nutrient-rich) if all effluent entered the reservoir. Bypassing up to 50 percent of the effluent would still produce eutrophic conditions. Bypassing 75 percent of the effluent would result in mesotrophic (moderately nutrient-rich) waters. Historically, water quality in the reservoir has been poor and addition of project effluent could accelerate reservoir eutrophication as well as adversely effect water quality in the North Unit Main Canal.

To confirm these predictions, however, monthly analyses for a year of samples collected at a number of points along the canal and in the reservoir for total P, orthophosphate P, NH_3-N, NO_3-N, NO_2-N, TKN, pH, DO, temperature and alkalinity would be a minimum program. Secchi depth and chlorophyll *a* analyses in Haystack Reservoir would also be appropriate.

If modifications to year-round canal disposal were implemented such as irrigation season canal disposal in combination with winter disposal to the subsurface or the Deschutes River, annual pollutant loading to the canal would be reduced by 42 to 50 percent, or by that amount no longer discharged to the canal in winter. If the effluent were to reach Haystack Reservoir, the potential for accelerating eutrophication would also be reduced.

In the case of canal disposal in combination with winter storage, pollutant loadings are difficult to estimate, because the degree of treatment while in storage is unknown, and can only be estimated. Assuming effluent from the storage reservoirs would be recycled through the filtering system prior to discharge in the canal, effluent quality from storage would be approximately equal to that being discharged directly from the treatment plant. Annual pollutant loadings would, therefore, be approximately the same as for year-round canal discharge, but would be accrued over the 6-1/2 month irrigation season rather than over the entire year. This means that daily pollutant loadings on the canal during the irrigation season would be somewhat greater than that stated for year-round canal disposal. However, the magnitude of this potential increase in pollutant loading can not be accurately estimated. In any event, a small elevation in daily pollutant loading would probably not change the potential for adverse impacts on water quality in the canal system beyond those stated for year-round disposal.

There is also a potential for adverse impact on the Deschutes River from effluent disposal to the North Unit Main Canal. Irrigation return flows to the Deschutes River from the canal system could contain additional nutrients and herbicides thereby further degrading existing river water quality.

Public Health

Impacts of Subsurface Disposal. Potential health hazards are associated with contamination of groundwater by bacteria and viruses and chemical compounds such as ammonia and nitrate, carcinogens, organics and toxic substances. Nitrate concentrations in groundwater over 10 mg/l measured as nitrogen have been documented as causing methemoglobinanemia "blue baby". Other compounds such as total dissolved solids can be harmful to people with cardiac, respiratory or viral diseases, if high levels are present in drinking water supplies. The fate of the other contaminants listed above cannot be determined with any degree of reliability. Suffice it to say that the mechanisms of filtration, adsorption and dilution would lessen the impact of these contaminants.

The potential contaminants of greatest concern are pathogenic bacteria and viruses. Dilution and disinfection, in most cases, renders potentially hazardous substances safer by lowering the risk of contamination. Particular features of these processes are described below. A more detailed accounting of the risk of effluent disposal to human health is available in appendix form upon request.

Dilution. Over one million acre-feet per year surfaces in springs in the Crooked River Canyon area north of Redmond. This is commonly used as a minimal estimate for groundwater flow. Complete mixing of discharge wastewater into this volume of groundwater would give a dilution ratio of 1 part effluent to 150 parts of groundwater. The dilution effect, however, would most probably be less than this since as stated by Sceva (1968) "once the waste water or effluent from a septic tank reaches a perched or regional water table, it flows down the hydraulic gradient. As most groundwater flow is under laminar conditions, there is much less dispersion of the effluent in groundwater than in surface water".

Disinfection. Saturated flow of groundwater through soil can be effective in the removal of bacteria as is shown in Table 6-3. To make a conservative estimate of the number of microorganisms transmitted through a relatively coarse medium, sedimentation should be considered the primary mode of action. In this instance the μ in Table 6-3 represents filterability by sedimentation. This ignores the other physical-chemical phenomena as well as natural die-off.

Assuming the coarsest sand size (0.11 cm) one would estimate that within 50 feet a 99.5 percent reduction in bacteria would occur; and within 100 feet the reduction would be in the range of 99.998 percent.

Recently, Dr. Robert Cooper, University of California, Berkeley, conducted a test in which a groundwater aquifer was recharged with secondary effluent to which polio virus, ECHO virus and coliphage was added. The sampling well was 25 feet from the injection well. The removal rate at this distance was 99.9999 percent. Thus, flow through the saturated zone appears able to remove considerable amounts of animal and bacterial viruses.

Table 6-3

REMOVAL OF COLIFORMS BY SEDIMENTATION IN SATURATED SAND
OF VARIOUS EFFECTIVE SIZES

Effective Sand Size cm	μ Value	Removal of Coliforms Per Travel Distance (c/c_o)**			
		0.5 ft.	5.0 ft.	10 ft.	15 ft.
0.11	0.0035	0.949	0.592	0.350	0.207
0.04	0.0169	0.776	0.008	0.006	0.0005
0.019	0.1200	0.165	1.52×10^{-8}	2.3×10^{-16}	3.5×10^{-24}
0.0063	2.000	9.3×10^{-14}	$<1.0 \times 10^{-99}$	$<1.0 \times 10^{-99}$	$<1.0 \times 10^{-99}$

*Flow rate 0.044 to 0.52 cm/sec

**Final concentration of coliforms/initial concentration

Adapted from: Krone, et al., 1958.

The aquifer will also present ion exchange capacity, biological activity and sorption capacity for inorganic and trace organic compounds. This will reduce even further the concentration of chemicals in the water of wells down gradient from the injection site. Eventually equilibrium will be reached and a rather constant concentration of the chemicals will be found in the pumped water.

The conclusion to be drawn is that the passage of water through a saturated zone can effectively remove biological agents and reduce the concentration of chemical agents. Subsurface disposal via infiltration ponds would be expected to provide a greater degree of removal efficiency than would drill hole disposal because effluent would pass through a layer of soil before entering the underlying strata. An adequate monitoring program would be necessary to determine the contaminant removal efficiency of the underlying rock formations as well as that of the infiltration ponds.

An additional health risk associated with infiltration ponds would be the potential for mosquito propagation. Bacterial or viral diseases could be transmitted to man or animals by this means.

It is expected that infiltration ponds, because of their strict operational design, would be fenced to prevent public access. Therefore, health risks relating to direct contact with effluent would be restricted to operators. Skin contact, as it might be associated with ingestion or food contact, would be of concern; however, good personal hygiene on the part of operators would presumably minimize potential problems.

Public health risks of a different nature would also be associated with the location of infiltration ponds in relation to the Bend Airport. According to FAA regulations (Chapter 5) any infiltration pond located on Site E in the vicinity of the new treatment plant would fall into the FAA prescribed safety zone and would thus pose a significant threat of bird strikes to aircraft approaching the airport. Any infiltration ponds within this safety zone would require wire screen or net covering to repel birds (D. Field, FAA, letter to EPA dated August 14, 1979). Infiltration ponds constructed in the natural depression to the east of Site E (see Figure 4-1) would not lie within the FAA safety zone.

Impacts of Deschutes River Disposal. Discharge of disinfected and filtered secondary effluent into the Deschutes River would result in dilution of the biological and chemical agents present in the effluent. To be conservative the lowest dilution during the wet and dry seasons were chosen. From these dilution ratios of 14 to 1 during the wet season and less than 2 to 1 during the dry season, it was determined that from November to March the treatment plant's contribution of coliforms would be about 1 per 100 ml, and about 2 viruses per liter. It should be noted that from 1970-1974 the coliform level observed in the water of the Deschutes River above Bend averages 680 per 100 ml (ranges from 23-7,000/100 ml) and the fecal coliform level averages 646 per 100 ml (ranges from 5-7,000/100 ml). The estimated contribution of the treatment plant would be extremely small compared to the reported background levels. During the dry season (April-October) the dilution would be correspondingly less, yet the contribution of coliforms would still be only a small percentage (approximately 1.5 percent) of the average background numbers of these bacteria.

Chemical compounds present in the discharge would be diluted in a manner similar to the biological agents. One would expect most heavy metal concentrations to be reduced to levels acceptable for drinking water. Nitrate would be significantly reduced in the wet season and much less so during the dry season. Nitrates are reported (1970-1974) to average 0.07 mg/l as NO_3-N in the Deschutes River above Bend. Thus, effluent from the treatment plant would give a large proportionate increase in nitrates but should be below acceptable drinking water maximum. During the dry season the dilution would be significantly less and the nitrate level would be greater accordingly.

As the biological and chemical agents move downstream there would also be some reduction due to natural decay, adsorption and other physical-chemical processes. The extent of the activity of these processes in the Deschutes River is unknown, particularly for chemical entities. The half life for viruses and bacteria in natural waters has been estimated to be in the range of 4 to 30 hours. Thus, unless a stream is particularly sluggish the impact of natural decay on relatively close, downstream stations should be negligible. In estimating the health risk to downstream water users the most conservative approach is to assume that these various removal processes would have a minimal effect upon chemical and biological agent concentrations.

The City of Redmond may in the future take drinking water from the Deschutes River during the dry season, the period of least dilution of the upstream Bend treatment plant effluent. Conventional water treatment processes (coagulation, sedimentation, filtration and disinfection) should effectively reduce biological agents present to an acceptable public health level. The removal of organic compounds by conventional water treatment is not anticipated, however, to be of any significant magnitude. Thus, if the increased organic load were to affect Redmond drinking water quality then activated carbon treatment would need to be added to the process. High nitrate levels could also cause problems to the Redmond water supply.

Individual water supplies taken from the river would normally not have the benefit of complete treatment. It is assumed that the microbial quality of the Deschutes River is presently questionable due to causes unrelated to Bend's municipal waste disposal. Thus, the anticipated contribution of bacteria and viruses from the proposed Bend discharge would not significantly increase the probability of infectious disease to those individual households who now use the river water. The chemical impacts could be more significant upon these individuals. As a safeguard, downstream domestic use of river water by private residences would probably be prohibited.

The public health threat to the recreationist using the river should be insignificant, although it should be noted that the low flow times of year would be the time of most swimming and recreational boating contact.

Impacts of Evapotranspiration Ponds. Daily pollutant loading to sealed evapotranspiration ponds and infiltration basins under this alternative would be 1,500 pounds BOD, 1,500 pounds suspended solids, 1,000 pounds ammonia and 400 pounds of phosphorus. Coliform bacteria levels would be approximately 1,000/100 ml of effluent.

Infiltration basins would be fenced to prevent public access. Evapotranspiration ponds developed as wetlands, however, could be made accessible to the public. Thus, the major public health risk would be from skin-to-mouth contact or from drinking effluent directly. As effluent travels through the series of evapotranspiration ponds, however, concentrations of the above pollutants should be reduced substantially through natural decay, uptake by aquatic vegetation and settling. Studies by Woodwell (1977) utilizing marsh environments to treat domestic sewage showed removal rates for inorganic nitrogen and phosphorus of over 90 percent within a period of seven days.

Bacterial concentrations in the effluent would be reduced over time by natural die-off. Survival time of pathogenic bacteria in water has been reported as being from several weeks to over three months (Pound and Crites, 1973). It should be noted, however, that coliform levels in the Deschutes River below Bend have been reported as high as 7,000/100 ml with no apparent effect on downstream uses.

Viruses in the effluent would also be subject to natural die-off over time with survival times in water reported less than one month for some organisms (Pound and Crites, 1973).

Mosquitos could also be potential carriers of diseases to man if propagation were to occur in evapotranspiration ponds or infiltration basins.

An additional public health threat is associated with the location of evapotranspiration ponds in relation to the Bend Airport as discussed previously under impacts of subsurface disposal-infiltration ponds on public health. Two tentative locations for evapotranspiration ponds would lie within the designated FAA safety zone and would, therefore, be unsuitable locations for marsh areas. One ponded area is located within Site E and a second, southernmost pond, is adjacent to the Powell Butte Highway (see Figure 4-3).

Impacts of Land Application by Spray Irrigation. Under this alternative, the public health concern would involve exposure to field workers, aerosol generation and contamination of the underlying groundwater. Crops to be irrigated would include various grasses, some of which can be used for animal fodder. No leaf or root crops for human consumption would be involved.

When reclaimed water is used for sprinkler irrigation the chances for ingestion of large volumes of water (100 to 1,000 ml) is rather small. The major route of contact would be from hands contaminated with reclaimed water placed in one's mouth, from ingestion/inhalation of aerosols generated by such activity or from drinking water directly. This latter situation may arise when workmen drink from irrigation hoses or hose bibs or in a situation in which the reclaimed water is accidently cross-connected with the potable water supply.

Skin contact should be of minimal concern except as it might be associated with ingestion or food contact. Good personal hygiene among those exposed should prevent any problem. An important route of contact will be respiratory. The ability of disease transmission via aerosols is an extremely complex combination of factors which include the nature of the agent, size of aerosol particles, distance of travel, relative humidity, sunlight, ambient temperature, characteristics of the exposed host, etc. At present the evaluation of the effect of aerosols upon the health of those exposed must be based upon existing field measurements and upon epidemiological experience in instances where wastewater is aerosolized.

No data are available which indicate that the aerosols generated by activated sludge plants have been the source of disease either for plant personnel or for downwind communities. Plant personnel are exposed to considerable aerosolized material originating from a significantly more concentrated source of agents than that proposed to be used in the Bend project. One hundred to two hundred feet should be considered an adequate sanitary buffer zone between activated sludge plants and houses.

The health effects of chemicals in reclaimed water used for irrigation have not been investigated except as runoff may affect surface supplies or chemicals, such as cadmium, may be translocated into edible plants. The impact of aerosolization of chemical agents has not been discussed in the open literature. The amounts of these agents in the applied water should generally be in the microgram level. The tremendous dilution effect of the air would be expected to reduce these concentration levels far below the background created by auto emissions, industrial effluvia and the like.

Although the land irrigation alternative does not offer a dilution effect, the soil mantle is recognized as an effective treatment system for wastewater. An estimate of coliform removal by soil systems can be made utilizing data from Table 6-4. In the most coarse soil (Oakley Sand) from one to three orders of magnitude reduction in coliform numbers would be expected within the first 3 feet of the soil horizon. If the application rates at the proposed Bend sites are less than 0.18 to 0.21 feet per day, then removal rates might be expected to be even greater. Thus, within a few feet of soil depth a coliform level in percolated water of less than 1 per 100 ml would be expected.

Data on virus-soil interactions are not as well developed as that for bacterial agents. Removal will be affected by application rates and clay content of the soil. In one study (Lance and Gerba, 1977) after application of viruses to rapid infiltration soil columns at hydraulic rates of 6 to 22 inches per day the detection of viruses was limited to soil depths less than 69 inches with 90 percent or more removed within the first few inches. It can therefore be concluded that the

Table 6-4

SOIL TEXTURE AND COLIFORM COUNT AT A DEPTH OF 3 FEET FOR FIVE SOILS UPON WHICH SEWAGE WAS SPREAD

	Effective Size (mm)	Flow Rate Feet per Day	Percent Coliform Removal
Hesperia sandy loam	0.0020	0.23	99.985-99.99997
Columbia sandy loam	0.0033	0.18	99.990-99.99997
Hanford sandy loam	0.0074	0.21	99.904-99.9998
Yale sandy loam	0.021	0.23	99.900-99.9998
Oakley sand	0.020	0.21	90.000-99.9782

Adapted from: Orlob and Butler, 1955.

occurrence of enteric viruses beyond a few feet of soil, when water of the projected quality to be produced at the Bend plant is applied, would be of low probability.

Nitrate generation or removal will depend upon application rate, soil type and crop. In some instances where long-term applications have been practiced, such as at Lubbock, Texas (Pound and Crites, 1973) increases in groundwater concentrations of nitrate have been observed.

Control of insects on a wastewater irrigation site is more critical than on a conventional irrigation site because of the possibility of effluent contamination by bacteria or viruses. Mosquitos could reproduce in storage reservoirs or on irrigation sites where any ponding of effluent occurs and thereby carry diseases transmittable to man.

Impacts of North Unit Main Canal Disposal. This alternative has similar aspects to effluent discharge to the Deschutes River; however, when the canal is in use, the dilution factor would be at least five times greater at low flow than that of the river.

The public health risk of greatest concern would be to users of canal water for domestic purposes in Madras. The city uses conventional water treatment processes to purify canal water for domestic use, which should effectively reduce any biological contaminants to acceptable public health levels. Removal of organic compounds and nitrates, however, might not be complete and could therefore adversely affect public health. The City of Madras reportedly has existing problems purifying poor quality canal water for domestic use (Miller, pers. comm.). Additional nutrients from effluent could aggravate this problem.

The risk of contracting bacterial-caused diseases should be minimal to users of canal water containing effluent for irrigation of crops or yards or to persons consuming crops irrigated with this water. Effluent would contribute an additional 10 MPN/100 ml to canal waters, an insignificant amount of pollutants when compared to background coliform levels as high as 7,000 MPN/100 ml potentially entering the canal at the diversion dam. This level of bacterial contaminants would be similar to coliform levels currently existing in several streams elsewhere in the state where river water, receiving treated sewage effluent, is used to irrigate crops grown for direct human consumption. For example, the Willamette River receives effluent from numerous city treatment plants (e.g., Eugene, Corvallis, Salem, Albany, etc.). Water from this river is used to irrigate a wide variety of truck crops including beans, onions, strawberries and carrots. Total coliform levels in this river have been reported as high as 5,000-6,000 MPN/100 ml with no adverse effects on irrigators or crop consumers reported to date (Carter, pers. comm.).

No state laws or statutes govern or restrict bacterial contaminant levels for irrigation of crops for direct human consumption except where irrigation water is undiluted effluent (see Chapter 5). Similarly, the health risk to recreationists using the canal or reservoir should also be minimal.

During 5-1/2 months of the year, when the canal is not in use, no dilution of effluent would occur. Public health risks during this period would be increased. Because the effluent would not be expected to travel a great distance down the canal before entering the subsurface (estimated to be 8 miles, BECON, Design Definition Memorandum #10), the public health risk would apply to a relatively limited area. However, if preliminary plans to line the canal for water conservation purposes are implemented in the future by the Bureau of Reclamation (R. Vissia, letter to EPA dated November 13, 1978), the risk of public contact with indiluted effluent in winter would be magnified.

Fisheries

Those effluent disposal alternatives, involving discharge to surface waters -- discharge to the Deschutes River and discharge to the North Unit Main Canal -- would have the potential for impact on resident fish species. A number of species of fish inhabit the Deschutes River and Lake Chinook. Among the most common are the rainbow and brown trout, which are thought to spawn in the Deschutes River between Lake Chinook and the Bend diversion dam. In 1970 an estimated 9,800 fish were caught in the river and reservoir. Rainbow trout were most common in the catch (Fies, pers. comm.). Haystack Reservoir and, to a lesser extent, the North Unit Main Canal, contain a variety of fish species, including kokanee, trout and crappie. The reservoir is a popular fishing area. Numerous private fish ponds divert canal water within the district.

Effluent disposal to the Deschutes River is projected to increase ammonia (NH_3) concentrations, which could adversely affect the fisheries resource. The presence of ammonia would have a twofold effect on the resource. The first has to do with the affinity of ammonia for oxygen, which is required to biologically convert ammonia to nitrates. This reaction would cause dissolved oxygen concentrations to decline. The second effect is a direct toxicity of ammonia to aquatic life.

The concentration of unionized ammonia which has been determined to provide safe levels for all species of aquatic life is 0.02 mg/l (Thurston, et al., 1978). The concentration of ammonia in the Deschutes River, which would result in toxic concentrations, is affected by the temperature and pH of the water. Based on a water temperature of 11.5°C and an average pH of 8, the allowable ammonia concentration is 1.0 mg/l. At the discharge point, however, concentrations of ammonia in the mixing zone would be approximately 1.2 mg/l. Special treatment facilities would therefore be required to lower the effluent ammonia concentration to a safe value.

Another potential problem is that of chlorine toxicity to aquatic life when chlorine concentrations are higher than the safe value of 0.003 mg/l (Thurston, et al., 1978). Based on low flow conditions in the river, this value would be exceeded and dechlorination of the effluent would have to be included to maintain the beneficial use of the fishery.

Effluent disposal to the North Unit Main Canal is also projected to increase ammonia concentrations in the canal system. However, at an average flow of approximately 700 cfs in the canal during the irrigation season, ammonia concentrations would be approximately 0.32 mg/l which is substantially below the allowable level of 1.0 mg/l. Therefore, ammonia should not adversely affect fish in the canal or reservoir.

Chlorine concentrations in the canal system would be approximately 0.006 mg/l at the discharge point. At a fish toxicity level of 0.005 mg/l, addition of chlorine to the canal could adversely impact the fisheries.

Accelerated eutrophication of Haystack Reservoir could also have an adverse impact on the reservoir fishery. Increased algae and aquatic plant growth could cause dissolved oxygen concentration to fall below tolerance levels of resident species, particularly cold water species, such as trout and kokanee. Extensive fish kills, thought to be the result of low dissolved oxygen concentrations in the reservoir, have occurred in the past under current reservoir water quality conditions. Additional nutrients added to the system by effluent discharge could aggravate this existing problem.

Wildlife

All alternatives of effluent disposal, except no action, would have some degree of impact on wildlife. Placement of disposal facilities (e.g., ponds, cropland, storage reservoirs) would result in long-term losses of wildlife habitat utilized by native species.

Habitat losses would be of greatest significance under the land application by spray irrigation alternative, which would require conversion of at least 1,350 acres of juniper-sage brush habitat to cropland. The infiltration and evapotranspiration alternatives would also impact substantial acreage. Habitat losses under these alternatives, however, when compared to available juniper-sage brush habitat in central Oregon, would be relatively insignificant.

In construction areas, subsurface dwelling and sedentary mammals and reptiles would be destroyed. More mobile species displaced from construction sites could also be lost, if surrounding habitat already supports a carrying capacity of that species.

Operation of the spray irrigation system, infiltration ponds and evapotranspiration ponds would produce some secondary benefits by providing new habitat for species adapted to agricultural practices and aquatic habitats (e.g., waterfowl, blackbirds, etc.). Establishment of "islands" of greenery could increase the density of some native species inhabiting adjacent undisturbed habitat through creation of an "edge" effect.

Vegetation and Soils

All effluent disposal alternatives, except no action, would have some degree of impact on existing vegetation. Placement of disposal facilities (e.g., croplands, storage reservoirs and ponds) would result in long-term native vegetation losses. The land application by spray irrigation, infiltration and evapotranspiration pond alternatives would have the greatest impact.

Both beneficial and adverse impacts on soils and vegetation may result from spray irrigation of effluent. Beneficial impacts include increased soil fertility, increased soil organic matter content, and more vigorous plant growth from nutrients such as nitrogen, phosphorus, potassium, lime trace elements and humus, supplied by the effluent. Potential adverse impacts of effluent disposal on soils and vegetation are overloading of organic matter, which could clog the soil and seal the surface and cause a buildup of nutrients, salts, or heavy metals in the soil, which could result in poor plant growth and eventually necessitate abandonment of the irrigation site.

Land Use

Impacts on land use would be most significant for those alternatives requiring large acreage, i.e., land application by spray irrigation, discharge to evapotranspiration ponds and discharge to infiltration ponds. Land proposed for use under these alternatives is publicly-owned BLM land. Current uses of the land include cattle grazing, hunting and other recreational uses. Conversion of BLM land for spray irrigation or infiltration ponds would preclude present land uses for the life of the project. Under the evapotranspiration pond alternative, secondary benefits could be provided by allowing public access for hunting, bird watching, etc.

Under the no-action alternative, no direct impacts on land use would occur.

Odors

Malodors resulting from discharge of effluent by any of the five main disposal alternatives are anticipated to be minimal. The secondary treatment process should remove most of the organic matter that might produce odors in decomposition. For disposal alternatives centered in or near Site E, the remoteness of the site should also reduce the potential of objectionable odors reaching populated areas.

Under the no-action alternative, any odors generated by effluent disposal would have a greater impact due to the close proximity of the existing treatment plant to residential areas.

Noise

Some noise would be generated by disposal facilities for all alternatives and by truck traffic serving the new treatment plant. However, due to the remote location of Site E from developed areas, the impact should be negligible.

Under the no-action alternative, continued operation of the present treatment plant and disposal facilities, coupled with increasing residential development in surrounding areas, would probably result in increased complaints about noise from heavy truck traffic serving the treatment plant.

Aesthetics

Under the subsurface disposal alternative, probably the only adverse impact on aesthetics relates to the drinking of groundwater in an area where sewage effluent is entering the groundwater aquifer. A series of disposal wells or infiltration ponds would have little adverse visual impact.

Effluent disposal to the Deschutes River, particularly in summer, would probably cause growth of algae on rocks in the river bed below the point of discharge, a condition that could be considered aesthetically displeasing.

Discharge of effluent to a series of evapotranspiration ponds developed as wildlife habitat should be aesthetically pleasing. Wetland vegetation developed amidst desert terrain would constitute a beneficial visual impact.

The impact of a spray irrigation system on aesthetics should be minor. The spray irrigation system would resemble irrigation systems presently used in the Bend area. The remoteness of Sites E and F and planned buffer zones surrounding each site should reduce any adverse visual impacts.

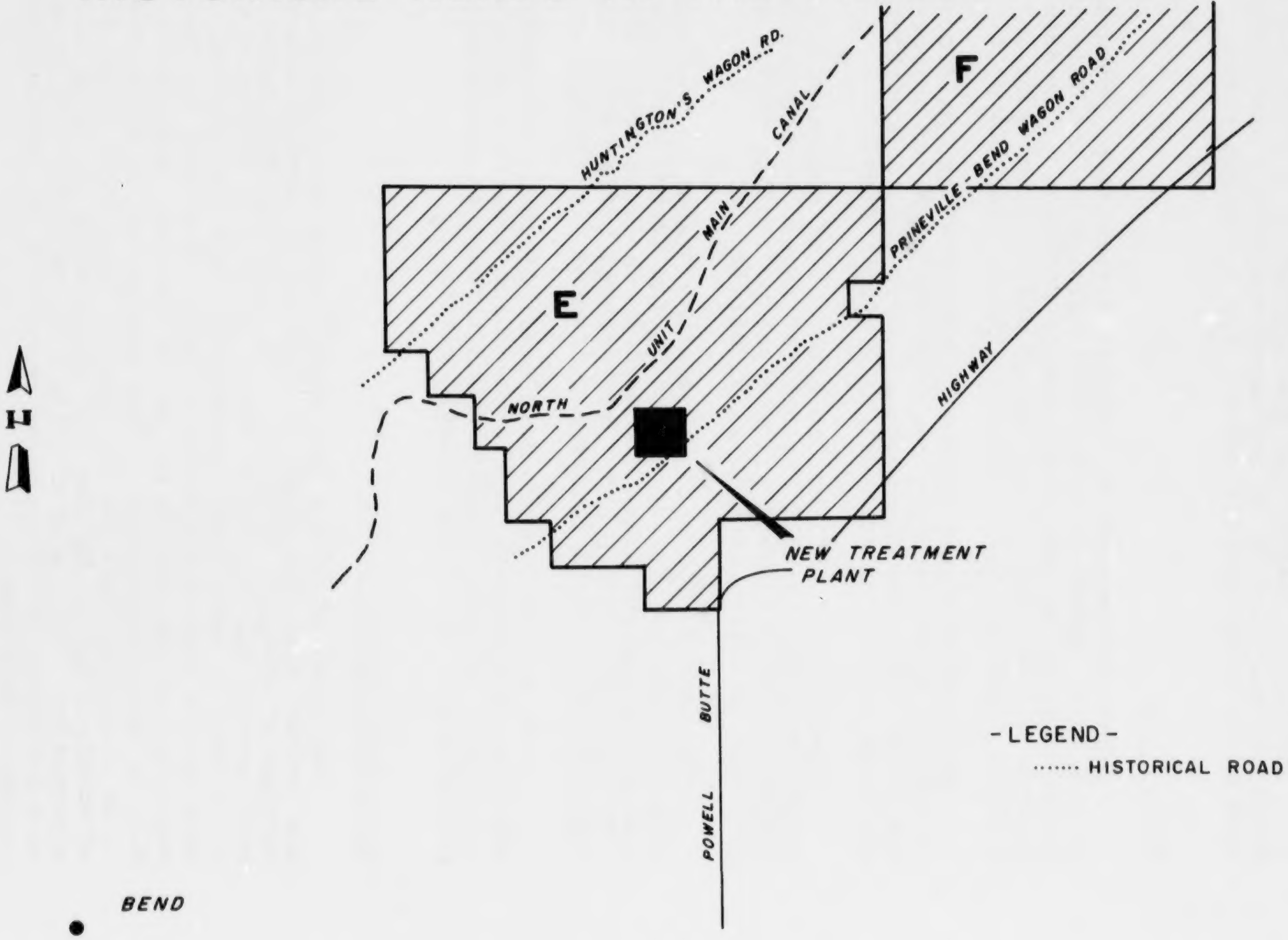
Under the North Unit Main Canal disposal alternative, addition of nutrients to the canal and reservoir in summer could have adverse visual effects through an increase in production of algae and aquatic plants.

Archeology/History

Two sites of historical significance are found within the project area and could be affected by several alternative methods of effluent disposal. The historic Huntington Wagon Road crosses the northwest corner of Site E (Figure 6-6). It is felt by some local authorities that the road was also used by the Meek Wagon Train in 1845. The road has been nominated as the Meek Trail to the National Register by the BLM, Prineville District. That nomination is still pending. It is projected that the Huntington Wagon Road would not be adversely impacted by the land application by spray irrigation alternative. This area of Site E is characterized by extensive rock outcrops, which would be unsuitable for development as irrigated cropland.

FIGURE 6-6

HISTORICAL ROADS IN THE PROJECT AREA


F
E
HUNTINGTON'S WAGON RD.
CANAL
MAIN
UNIT
NORTH
PRINEVILLE-BEND WAGON ROAD
HIGHWAY
NEW TREATMENT PLANT
BUTTE
POWELL
BEND
-LEGEND-
.... HISTORICAL ROAD

A second road of historical importance passes through Sites E and F (Figure 6-6). This is the Prineville-Bend Wagon Road. A nomination to the Oregon State Inventory of Historic sites has been filed for this road. The alternatives involving effluent disposal via land application by spray irrigation, infiltration ponds and evapotranspiration ponds could adversely impact this road.

A number of archeological sites containing cultural material occur on Site E. Construction of a spray irrigation system could adversely impact these sites.

Resource Consumption

Resources consumed during operation of each disposal alternative includes, where appropriate, primary energy to operate the treatment plant, the filtration system and pump effluent to the disposal site and chlorine to disinfect the effluent. Secondary energy consumption relates to energy and fuel required to manufacture and transport the chlorine used in the treatment process. Figures 6-7 and 6-8 compare annual primary and secondary energy use, respectively, for the five major alternatives. The land application by spray irrigation alternative would require the greatest primary energy use due to energy needs for pumping effluent to spray irrigation systems. Both the infiltration pond and evapotranspiration pond alternatives would require no primary energy use because effluent would be conveyed by gravity flow to the disposal point. Secondary energy usage would be lowest for both subsurface disposal via drill holes and discharge to the North Unit Main Canal.

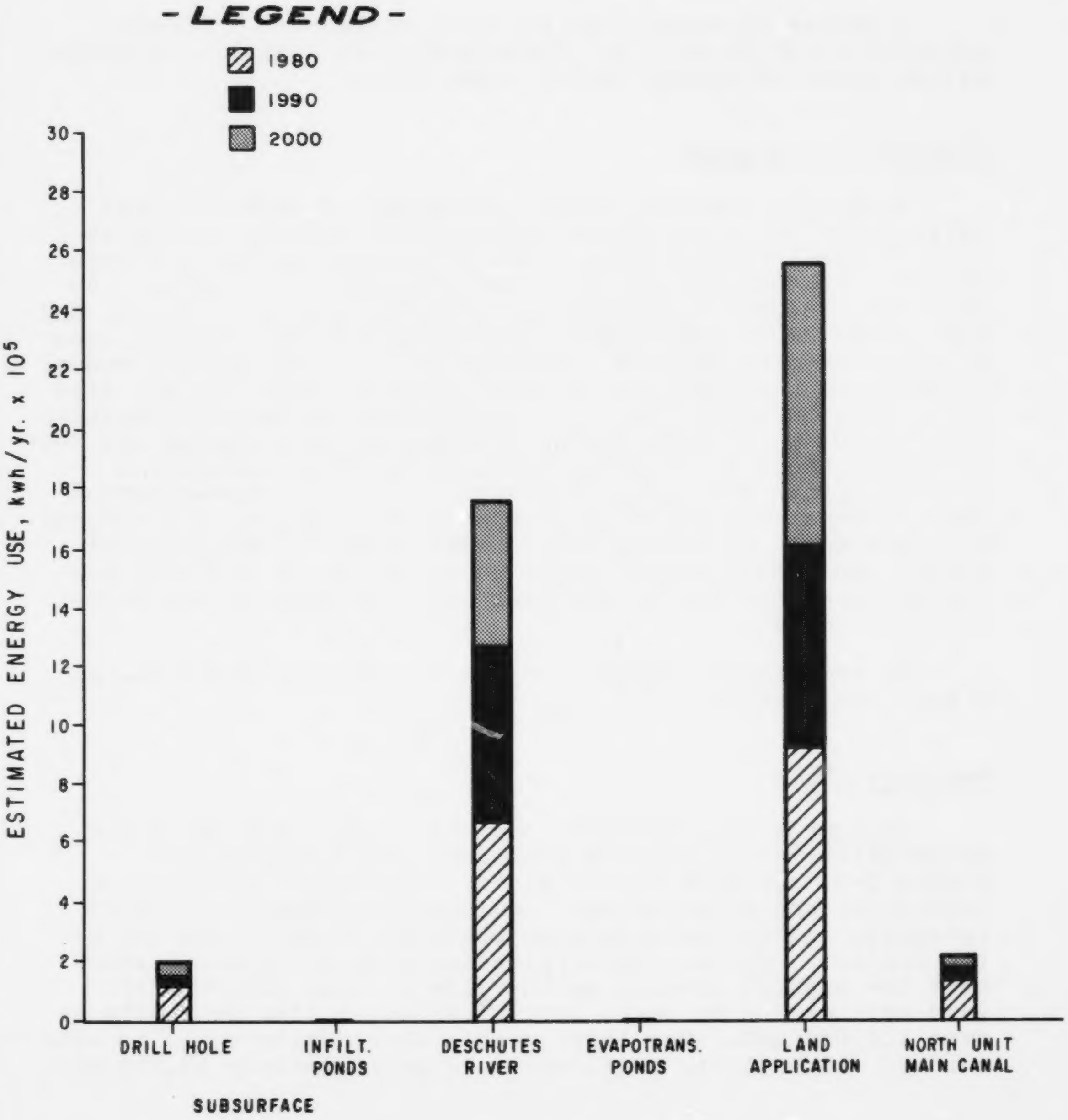
No additional resources would be consumed under the no-action alternative.

Monetary Costs

Present Worth. Estimated present worth values of the major effluent disposal alternatives are compared in Figure 6-9. Present worth values include initial costs of facilities and construction, equipment replacement, annual operation and maintenance minus salvage value at the end of the project. The evapotranspiration pond alternative would have the highest present worth value of over $28,000,000. Land application by spray irrigation would also be costly at over $24,000,000. The least costly alternative would be subsurface disposal via drill holes at approximately $2,600,000.

FIGURE 6-7

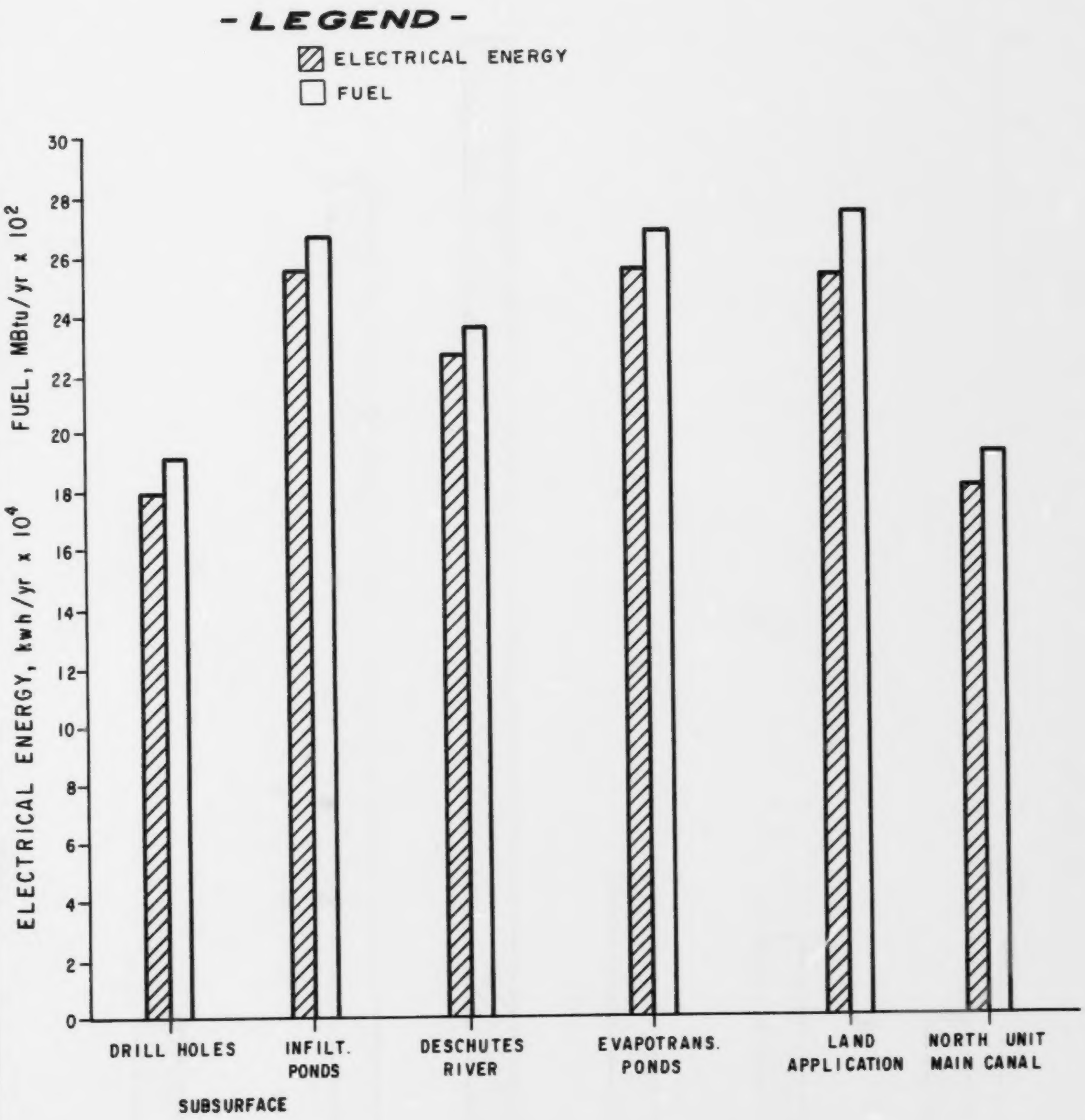
PRIMARY ENERGY USE



MAJOR ALTERNATIVES

FIGURE 6-8

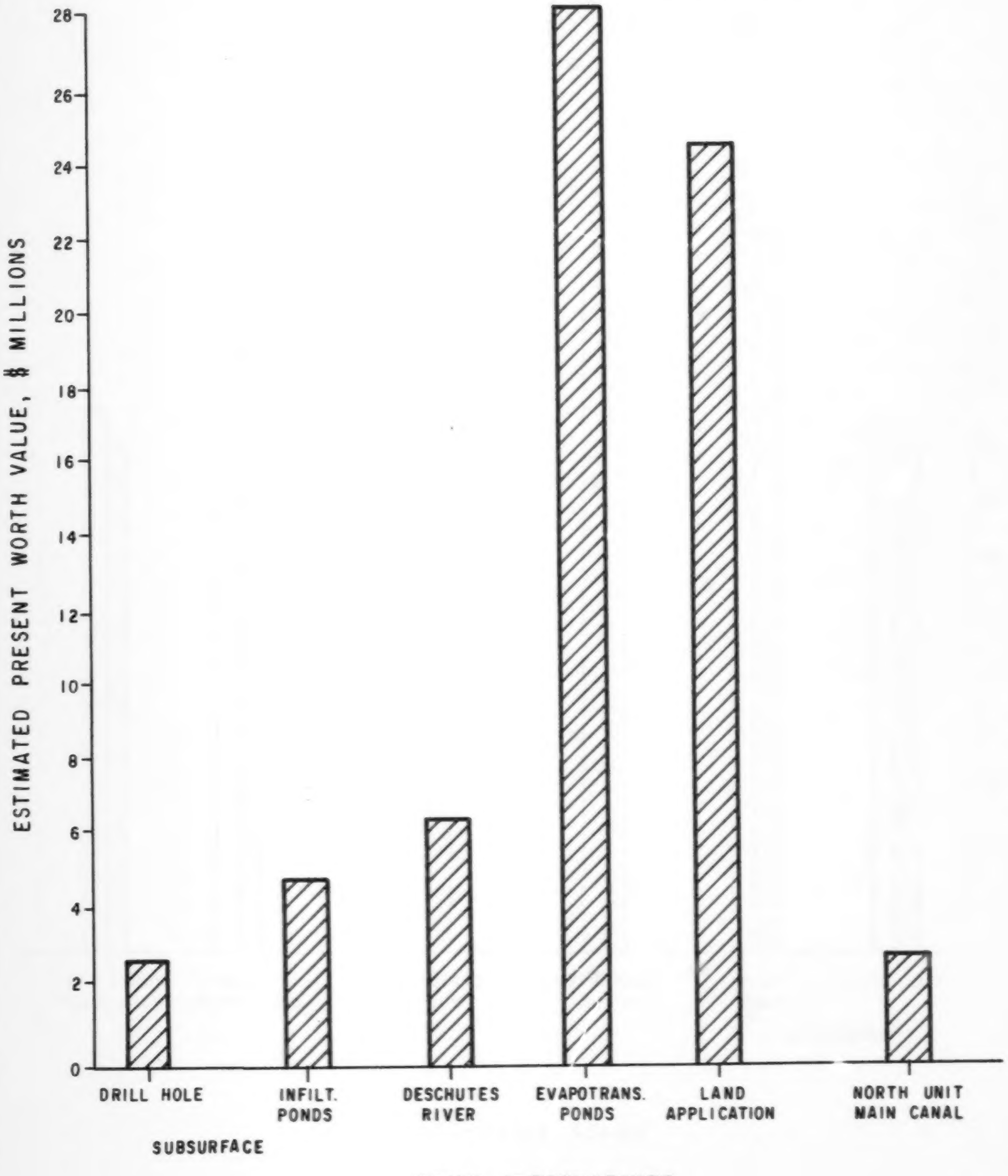
ESTIMATED SECONDARY ENERGY REQUIREMENTS



MAJOR ALTERNATIVES

FIGURE 6-9

ESTIMATED PRESENT WORTH VALUES



Modifications of year-round discharge to the North Unit Main Canal to avoid winter discharge, i.e., combining irrigation season discharge to the canal with winter discharge to: 1) the subsurface via drill holes or infiltration ponds; 2) the Deschutes River; or 3) winter storage, would have present worth values ranging from $3,424,000 to $8,445,400. Combined canal and drill hole disposal would be least costly.

In the event that the land application by spray irrigation or evapotranspiration pond alternatives would be eligible for an additional 10 percent grant funding by the EPA as innovative or alternative technologies, present worth costs of these alternatives would be reduced to a substantial degree.

No additional costs would be generated under the no-action alternative. However, if the no-action alternative was adopted, monies expended for construction of the new treatment plant on Site E would essentially be wasted.

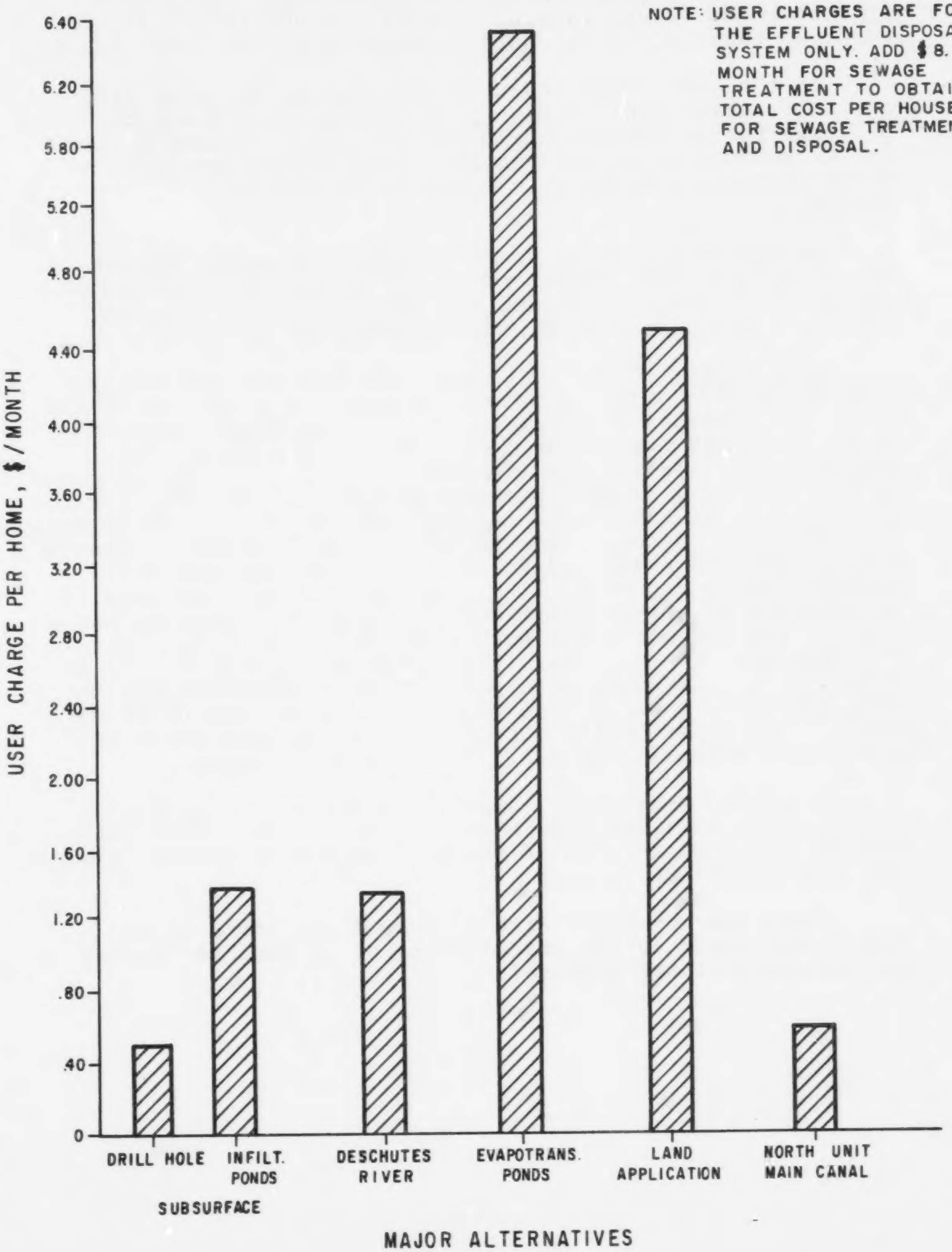
User Costs. Costs presented here are for the effluent disposal system only. However, to gain a perspective of the total user charges to be expected, an approximate value of $8.25 per month per single family home was computed for wastewater collection and treatment. This value was computed by assuming full federal particiipitation (75 percent) for the treatment plant and sludge handling system and no participation for the sewer system. This amount should be added to the monthly charges presented to obtain the approximate total monthly charge per home. The local annual cost analysis is an estimate of the probable cost individual homeowners would have to pay per month for each alternative if it was constructed. The results of this analysis are presented in Figure 6-10. As would be expected, the evapotranspiration pond alternative would have the highest user cost of $6.39/month. The least costly alternative to the user would be subsurface disposal via drill holes at $0.54/month.

As stated previously, user costs for the evapotranspiration ponds and land application by spray irrigation alternatives would be reduced if these alternatives become eligible for additional EPA funding.

Under the no-action alternative, there would be no additional costs (other than inflation) to Bend residences for sewage effluent disposal.

FIGURE 6-10

USER CHARGE PER HOME



NOTE: USER CHARGES ARE FOR THE EFFLUENT DISPOSAL SYSTEM ONLY. ADD $8.25/ MONTH FOR SEWAGE TREATMENT TO OBTAIN TOTAL COST PER HOUSEHOLD FOR SEWAGE TREATMENT AND DISPOSAL.

Monthly user costs of implementing modifications to year-round North Unit Main Canal Discharge would range from $0.69 to $1.74 per connection. The combination of canal and drill hole discharge would be least costly.

Other Secondary Cost Impacts. Significant increases in costs of controlling aquatic weeds in the North Unit Main Canal system could result from discharge of effluent into the canal at Bend. The North Unit Irrigation District has a severe and continuing problem controlling aquatic weeds in their main canal and laterals. The District is obligated to maintain capacity to deliver water to its users and assure acceptable water quality. Excessive amounts of aquatic plant debris reportedly clog structures, turnouts, head ditches, sprinkler screens and heads and siphon tubes.

Projected use and costs of aquatic herbicides by the District in 1979 is shown in Table 6-5. The total estimated cost of herbicide use is $19,705. Costs of labor, equipment and overhead for application of herbicides is generally equal to at least their purchase price. Thus, the total cost of aquatic weed control in the North Unit Irrigation District should be about $39,400 in 1979 (R. Vissia, U. S. Bureau of Reclamation, letter to EPA dated November 13, 1978).

It has been estimated by the Bureau of Reclamation that addition of the City of Bend effluent to the canal system would double or triple the aquatic weed problem. A doubled aquatic weed control program would cost the District an additional $40,000 annually at present day dollars.

Other secondary cost impacts to the North Unit Irrigation District would be related to maintenance of the canal structure. Damage to the structural integrity of the canal could potentially occur during winter effluent discharge to an empty canal. Other irrigation districts in the project area that commonly have winter runs in their canals to allow domestic cistern filling, experience maintenance problems from ice buildups. With an average effluent flow of 9 cfs from a 6 mgd capacity treatment plant and an estimated 11 percent seepage loss, water depth in the North Unit Main Canal would be only about 2 to 3 inches. However, it has been reported that ice buildups from flows as low as 10 cfs can result in structural damage to project area canals (Wagner, pers. comm.). Actual costs of increased canal maintenance, however, have not been estimated.

Additional potential secondary cost impacts associated with effluent discharge to the North Unit Main Canal relate to legal liability of the Irrigation District in the event that any person or his/her property is adversely affected by canal water containing effluent contaminants. There is

Table 6-5

PROJECTED 1979 USE AND COSTS OF AQUATIC HERBICIDES - NORTH UNIT IRRIGATION DISTRICT

Material	Amount	$ Cost
Xylene	10,500 gal.	7,004.00
Emulsifier	165 gal.	937.00
Magnacide H (acrolein)	832 gal.	9,568.00
Copper sulfate	6,000 lbs.	2,196.00
TOTAL		19,705.00

Source: R. Vissia, Bureau of Reclamation, letter to EPA dated November 13, 1978.

potentially no limit to the magnitude of this cost impact; however, it should be noted that any person(s) bringing suit against the District for alleged personal harm would have to prove conclusively that canal effluent contaminants caused their disorder. The probability of proving such a case during the irrigation season would be highly unlikely taking into account existing canal water quality and the unlimited sources by which contaminants could make their way into the canal system. In winter, however, no dilution of effluent would occur resulting in a greater likelihood that any harmful effects to persons coming in contact with the effluent stream could be more easily proved. Costs of liability insurance for the District were estimated to be approximately $1,000 annually (BECON, Design Definition Memorandum #10).

Discharge of effluent to the North Unit Main Canal system could also have a secondary economic impact on the private resort at Haystack Reservoir. Any adverse changes in the quality of water in the reservoir (eutrophication leading to increased algae and aquatic plant growth) could reduce recreational use of the reservoir, thus reducing income of the resort. The magnitude of this potential adverse impact on the resort, however, cannot be estimated.

For those alternatives involving potential impact on drinking water supplies, including the no-action alternative, secondary cost impacts could be associated with necessity to provide alternate sources of drinking water for affected users. Under the subsurface disposal and no-action alternative, contamination of groundwater supplies in the Bend area would require that all affected wells be deepened to utilize the isolated deep artesian aquifer. Costs associated with this requirement would depend on the number of contaminated wells and could be highly significant. Under the Deschutes River discharge alternative, domestic use of river water could be prohibited requiring private users and the City of Redmond to find alternate sources -- also a potentially significant cost impact of unknown magnitude. Under the North Unit Main Canal disposal alternative, the City of Madras might also be required to develop an alternative source to canal water use in summer. An additional city well could be drilled for this purpose at an estimated cost of $800,000 with annual maintenance costs of $15,000 (BECON, Design Definition Memorandum #10).

Under the no-action alternative, an additional secondary cost impact of unknown magnitude would be associated with potential effluent overflow from the lava tube presently used for subsurface disposal. Backup of effluent could result in considerable damage to residential areas surrounding the treatment plant.

Secondary costs would also be associated with the ability to expand the chosen effluent disposal alternative in the future. The population in the Bend service area is forecast to increase throughout the 20-year planning period. Associated with an increase in population would be an increase in wastewater flows which would have to be accommodated by expanding the treatment and disposal facilities. The disposal alternative that could be expanded using the least number of facilities and would also be the least land-consumptive were considered to be easiest and least costly to expand. Accordingly, the ranking is as follows:

1. Drill hole disposal, North Unit Main Canal discharge, Deschutes River discharge.
2. Infiltration ponds.
3. Evapotranspiration ponds, land application by spray irrigation.

Mitigation Measures

To reduce potential adverse impacts of the alternative methods of effluent disposal, the following mitigation measures are proposed.

Subsurface Disposal - Drill Holes. Subsurface disposal of effluent, particularly in the case of discharge to drill holes, will be accompanied by a monitoring program under which appropriate groundwater bodies will be sampled periodically (EPA letter to DEQ, 3-16-78). However, mitigation through a monitoring program has not been defined at this time. A description of a potential monitoring program follows. Sampling well stations would be positioned so as to intercept any effluent-related groundwater flow before it moves beyond site boundaries. Any present and future wells for some distance in the general direction of groundwater flow should also be included. Other wells adjacent to the site should also be sampled. Sampling might be at 3-month intervals initially and adjusted later if appropriate. The static piezometric surface should be monitored before each sampling.

Such water quality surveillance should commence at least 1 year prior to actual subsurface effluent disposal to provide a background data base. Analytical quality determinations would be designed to detect measurable amounts of effluent. It is tentatively considered that a minimum of three water quality monitoring wells might be adequate, one about 1/4 mile north of the disposal point and two about the same distance inside the north site boundary downstream, spread about 1/2 mile apart. Additional surveillance points may be in order after analysis of preliminary exploratory data.

Design standards and criteria for subsurface disposal wells can be determined only after deep drilling exploration and testing at the project site is completed. Design criteria would include optimum depth and diameter of the disposal well(s), depth of casing, number of wells, locations, and other factors.

Prior to actual discharge of effluent, a program of subsurface discharge tests using canal water should be conducted.

At such time as monitoring results indicate impending contamination of off-site groundwater supplies by subsurface disposal of project effluent, then a more intensive sampling program could be initiated to confirm problems and define them in greater detail. Additional monitoring stations may have to be drilled. If project operations are clearly shown to be damaging the usability of groundwater resources, an alternate method of disposing of plant effluent must obviously be put into effect.

The potential mitigating circumstance of greatest importance in this situation is the underlying deep artesian aquifer. Its existence beneath the general area is reasonably indicated, but remains to be proven. Being under considerable artesian head, it is probably not subject to any significant contamination from surface sources in this area. Thus, if the overlying aquifer zone is contaminated by subsurface effluent disposal this lower zone is presumed to be available as an alternative water supply source. Therefore, it is important that the existence of this aquifer in the Bend area be explored in greater detail.

Subsurface Disposal - Infiltration. A similar monitoring program should also be implemented for effluent disposal to infiltration ponds. Ponds should be properly maintained by discing infiltration sands and soils on a periodic basis to prevent clogging of the filtering medium. Insect vectors could be controlled, if necessary, with insecticides.

Discharge to the Deschutes River. To reduce public health risks to domestic users of Deschutes River water, advanced wastewater treatment would have to include nitrate removal, a very costly treatment process. The only other alternative would be to provide alternate sources of drinking water for all domestic users below Bend. To determine the number of affected domestic users downstream, a program would be necessary to monitor effluent contaminant concentrations at various points below the discharge point.

To protect the fishery resource, wastewater treatment would require ammonia and chlorine removal during periods of low flow in the river.

Discharge to Evapotranspiration Ponds. To reduce public health risks, insect vectors could be controlled by stocking ponds with mosquitofish (Gambusia) or by using insecticides. Initial ponds in the series, as well as the infiltration pond, could be fenced to prevent public access thereby reducing the risk of public contact with undiluted effluent. Ponds further down in the series would have the benefit of more complete effluent treatment through processes of natural decay and biological decomposition, thus reducing public health risks. The pond series should also be designed to prevent pond stagnation, a result of poor water circulation. An education program could be implemented to inform the public of general precautions that should be taken when coming in contact with sewage effluent.

Land Application by Spray Irrigation. Due to expected low concentrations of viruses and chemical compounds in the secondary effluent, combined with the filtrative capability of the soils and vegetation, contamination of the groundwater and a resultant public health risk are unlikely. As a safeguard, however, test wells should be established and monitored. Monitoring requirements would be much less intensive than in the case of subsurface disposal. The closest wells on all sides of the project site should be monitored. Also, in the absence of existing wells, monitoring wells should be drilled to the first usable aquifer encountered. They should be spaced on 1 mile centers along the northern site boundary, 1/8 to 1/4 mile outside the site. Sampling of these stations should be quarterly, beginning approximately 1 year prior to project start-up.

Soils and soil water could be monitored periodically to determine any deficiencies in crop nutrients or disclose a buildup of any substance that could be harmful to crop production. However, due to the high porosity of soils on Sites E and F and the expected low concentrations of nutrients, salts, and heavy metals in the effluent produced at the new treatment facility, toxic buildups in soils or vegetation is not expected.

Advanced wastewater treatment using sand filtration, which would remove essentially all bacteria and viruses, would substantially reduce any possible health hazards to irrigation system operators and the general public from pathogenic contamination of water, soils, air or vegetation. Planned buffer zones of native vegetation approximately 1,000 feet wide surrounding each irrigation site should reduce aerosol travel. Low trajectory nozzles would also limit aerosol travel. The warm, dry climate of the Bend area should effectively reduce survival of airborne bacteria and viruses.

Mosquito propagation on irrigation sites could be controlled by use of insecticides. Such practices, however, could involve some degree of environmental degradation and would probably serve only as a temporary solution. Drying periods between wastewater applications or reduction of hydraulic loading rates would reduce breeding opportunities on irrigation sites.

To mitigate wildlife and wildlife habitat losses, if possible, construction activities should be scheduled to avoid disturbances during the breeding season, thus reducing overall losses of nesting birds and some mammals. Adjacent native habitat could be enhanced through creation of brush piles, or range management for preferred food plants or exclusion of cattle.

Discharge to the North Unit Main Canal. To reduce adverse impacts of canal effluent disposal, a number of mitigation measures could be implemented. To mitigate public health risks associated with domestic water use, monitoring of the Madras water treatment plant could be conducted during the irrigation season. If contamination was detected, one or more new water wells could be constructed for the City of Madras to replace use of canal water in summer.

A public education program could be implemented to provide information to irrigators and recreationists on potential health hazards and public health risks of coming into contact with canal water containing effluent. In addition, the City of Bend could assume liability for any claims against the District concerning harmful effects of effluent discharge into the canal.

To mitigate increased costs to the District for aquatic weed control, the City of Bend could reimburse the District for estimated additional expenditures. The only other alternative would be to upgrade effluent treatment. AWT processes providing phosphorus removal would probably be appropriate. Establishment of a monitoring program would provide valuable information on pollutant levels in the canal.

Use of the canal in winter for effluent disposal would presumably require negotiations between the Bureau of Reclamation and the North Unit Irrigation District to amend the present amendatory repayment contract. If winter discharge was deemed acceptable, a monitoring program, similar to that described for subsurface disposal, would be appropriate. A number of test wells could be drilled near canal seepage areas to detect any groundwater contamination of perched or deep groundwater aquifers. Domestic wells located near the canal could also be monitored periodically. Implementation of modifications to year-round canal discharge (e.g., winter storage, winter drill hole disposal) would eliminate any adverse impacts associated with winter discharge to the canal.

No-Action Alternative. Inasmuch as there is no current basis for estimating effects on groundwater from continuation and increases in the present disposal practices, a carefully formulated surveillance program as well and river sampling would be needed to alert the community should problems exist or arise in the future. In the event of the contamination of water resources by septic tank disposal, it would appear essential that households adopt alternate wastewater systems, regardless of cost. New water wells would have to be drilled to the deep artesian aquifer to replace contaminated wells. Were the city treatment plant found to be polluting, then the only apparent remedy would be to upgrade the level of treatment.

Local Short-Term Uses of the Environment vs. Maintenance and Enhancement of Long-Term Productivity

The present discharge of inadequately treated wastewater to the subsurface through individual disposal wells represents a short-term use of the environment that could adversely affect the long-term productivity of the regional groundwater aquifer.

All alternatives of effluent disposal could decrease the potential for contamination of groundwater and public health risks. Those alternatives not involving direct discharge of effluent to the subsurface would afford the greatest protection against groundwater contamination. Several alternatives considered involve discharge to surface waters and therefore could be viewed as a trade-off between potential groundwater contamination and potential degradation of surface water quality, which would increase public health risks to domestic water users on the Deschutes River and North Unit Main Canal. Those alternatives relying on natural vegetative and/or soil systems for pollutant removal, i.e., infiltration ponds, land application by spray irrigation and evapotranspiration ponds should be most reliable in preventing contamination of either groundwater or surface water drinking supplies.

Adoption of the no-action alternative would allow for continued subsurface discharge of inadequately treated wastes. An even greater risk to public health from groundwater contamination would develop as population growth occurred in the Bend area.

Irreversible and Irretrievable Commitment of Resources

With all alternatives, except no-action, there would be minor and major irreversible and irretrievable commitments of renewable and nonrenewable resources. Significant commitments of irrecoverable resources, such as building materials, piping, time and energy would be required during construction of all alternative methods of effluent disposal. Alternatives involving extensive land use, i.e., infiltration ponds, land application and evapotranspiration ponds, would result in irreversible losses of some wildlife and native vegetation. Discharge to surface waters could cause irreversible losses of some game fish.

After construction, operation of each alternative would require irrecoverable commitments of time, chemicals, energy and maintenance materials. Land application by spray irrigation would require the greatest commitment of operational resources.

Unresolved Issues

As discussed in Chapter 6, no definite conclusions can be drawn regarding the potential impacts of subsurface effluent disposal at Site E on groundwater. Results of a recently completed geologic investigation conducted by BECON on Site E should provide greater insight into potentials for groundwater contamination (BECON, preliminary draft, September 1979). It is anticipated that final results of these studies will be available for inclusion and evaluation in the final EIS.

List of Preparers, Bibliography, [illegible]

Chapter 7

LIST OF PREPARERS

Charles R. Hazel, Ph.D., Vice President, Jones & Stokes Associates, Inc., Sacramento, California. Project Manager.

Karen J. Miller, M.S., Jones & Stokes Associates, Inc., Portland, Oregon. EIS Coordinator.

Robert B. Williams, P. E., Culp/Wesner/Culp, El Dorado Hills, California. Sanitary Engineering.

Robert C. Gumerman, Ph.D., P.E., Principal, Culp/Wesner/Culp, Santa Ana, California. Sanitary Engineering, Cost Comparisons.

William C. Ellis, Registered Geologist, Certified Engineering Geologist, Cooper-Clark Associates, Los Altos, California. Geology and Groundwater.

Robert C. Cooper, Ph.D., Department of Biomedical and Environmental Health Sciences, School of Public Health, University of California, Berkeley. Sanitary Engineering, Bacterial, Viral Analyses of Water Supplies.

Donald B. Porcella, Ph.D., Associate Director, Utah Water Research Laboratory, Utah State University, Logan. Civil Engineer, Nutrient and Eutrophication Analyses.

Garry Stephenson, M.S. Candidate, Department of Anthropology, Oregon State University, Corvallis. Archeology and History.

John A. Draper, M.S. Candidate, Department of Anthropology, Oregon State University, Corvallis. Archeology and History.

Chapter 8

BIBLIOGRAPHY

Literature Cited

Bend Engineering Consultants. 1977a. City of Bend, Oregon. Wastewater collection, treatment and disposal facilities; supplemental Environmenal Impact Assessment. Amendment No. 1 to Sewerage Facilities Plan.

----------. 1977b. City of Bend, Oregon. Wastewater collection, treatment and disposal facilities. Design Definition Memoranda Nos. 1-9.

----------. 1979. City of Bend, Oregon. Wastewater collection, treatment and disposal facilities. Design Definition Memorandum No. 10.

----------. 1979. Summary. Subsurface effluent disposal. Preliminary Draft. September 20, 1979.

Cooper, Clark & Associates. 1979. Geotechnical investigations, Bend, Oregon. July 16, 1979.

Krone, R., G. Butler and C. Hodgkinson. 1958. Movement of bacteria through porous medium. Sew. and Ind. Wastes 30:1.

Lance, J. C., and C. Gerba. 1977. Nitrogen, phosphate and virus removal from sewage water during land infiltration. Prog. Water Technology 9:157. Pergamon Press, Great Britain.

Oregon. Department of Environmental Quality. 1976. Oregon air quality report, 1976.

----------. 1977. Assessment of stream quality in Oregon based on evaluation of data collected in the 1976 stream sampling program.

Orlob, J., and R. Butler. 1955. An investigation of sewage spreading on five California soils. Tech. Bull. 12, I.E.R. Series 37; S.E.R.L., Univ. of CA, Berkeley.

Pound, C., and R. Crites. 1973. Wastewater treatment and reuse by land application. Vols. I, II. U. S. Environmental Protection Agency. EPA 606/2-73-006a,b.

Preceding page blank

Sceva, J. 1968. Liquid waste disposal in the lava terrane of central Oregon. U. S. Dept. of Interior, Federal Water Pollution Control Admin.

Stevens, Thompson, and Runyan, Inc. and Tenneson Engineering Corp. 1976. Sewerage facilities plan. City of Bend, Oregon. Vol. I, II.

Storet. 1978. Water quality data for Oregon. Available from the Water Pollution Control Lab., Dept. of Environmental Quality, Portland, OR.

Thurston, R. V., et al. 1978. Review of the E. P. A. redbook: Quality criteria for water. Preliminary edition. Water Quality Section, American Fisheries Society.

U. S. Bureau of Reclamation. 1972. Deschutes project, central division, Oregon. Potentials for expansion and improvement of water supplies.

U. S. Department of Agriculture. 1958. Soil survey for Deschutes County, Oregon.

U. S. Department of Commerce. 1977. 1974 census of agriculture, Oregon state and county data. Vol.I, Part 37.

U. S. Environmental Protection Agency. 1977a. Waste disposal practices and their effects on groundwater. Report to Congress.

----------. 1977b. Irrigation wastewater disposal well studies - Snake Plain aquifer. Ecological Research Series, EPA 600/3-77-071.

Woodwell, G. M. 1977. Recycling sewage through plant communities. Amer. Scientist 65(5):556-562.

Personal Communications

Carter, G. 1978-9. Oregon State Department of Environmental Quality. Portland, OR.

Edwards, R. 1978. City of Redmond. Redmond, OR.

Estes, B. 1978. Oregon State Water Resources Department. Salem, OR.

Fies, T. 1978. Oregon State Department of Fish and Wildlife. Bend, OR.

Miller, B. 1978. City of Madras. Madras, OR.

Ossenkop, D. 1979. U. S. Department of Transportation, Federal Aviation Administration. Seattle, WA.

Paterno, P. 1979. Bureau of Land Management. Prineville, OR.

Perry, N. 1978. Oregon State Water Resources Department Salem, OR.

Sceva, J. 1979. U. S. Environmental Protection Agency. Seattle, WA.

Schwartz, E. 1978. Oregon State Department of Fish and Wildlife. Prineville, OR.

Shimek, R. 1978. Oregon Department of Environmental Quality. Bend, OR.

Wagner, R. 1978. North Unit Irrigation District. Madras, OR.

Williams, E. 1979. U. S. Bureau of Reclamation. Boise, ID.

Agencies and Organizations Contacted

Bend, (City of), Oregon

- J. Donahue
- M. Elmore
- A. Johnson

Bend Engineering Consultants

- P. Case
- N. Dempsey
- W. Lapsley
- G. Lynch

Century West Engineers

- J. Beemer
- T. Cooper
- M. Hanley
- D. Newton

Madras (City of), Oregon

- B. Miller

North Unit Irrigation District, Madras, Oregon

R. Wagner

Oregon, Department of Environmental Quality

Bend:
- T. Hall
- R. Shimek

Portland:
- G. Carter

Oregon, Department of Fish and Wildlife

Bend:
- T. Fies

Prineville:
- E. Schwartz

Oregon, Water Resources Department

Bend:
- R. Main

Salem:
- B. Estes
- K. Mathiot
- N. Perry

Redmond (City of), Oregon

R. Edwards

U. S. Bureau of Land Management, Prineville, Oregon

P. Paterno
N. Steggell
M. Ziegler

U. S. Bureau of Reclamation

Salem, Oregon:
- R. Kannasto

Boise, Idaho:
- C. Daly
- G. Lee
- F. Oliver
- L. Persson
- N. Stessman
- V. Temple
- E. Williams

U. S. Environmental Protection Agency, Seattle, Washington

B. Mullen
J. Sceva
H. Scott

U. S. Federal Aviation Administration

Seattle, Washington:
D. Ossenkop

Salem, Oregon:
R. Costello

U. S. Forest Service

Bend, Oregon:
L. Chitwood

Prineville (Crooked River National Grassland), Oregon:
C. Hylton

U. S. Geolcgical Survey, Portland, Oregon
J. Gonthier

Chapter 9

APPENDICES

Preceding page blank

Appendix 1

SUBSURFACE DISPOSAL OF EFFLUENT VIA INFILTRATION PONDS

Culp, Wesner and Culp
July 1979

Physical Facilities

This alternative requires that all effluent be discharged on a year-round basis to an infiltration/percolation pond area. Treated water would be delivered to the spreading ponds by means of an estimated 42-inch diameter gravity flow pipe. Once at the ponds, the water would be distributed into four cells and allowed to percolate through the surface media to the substrate.

Construction of the infiltration pond would require the construction of approximately four cells in the infiltration area. The cells would be separated by dikes or berms. The berms would have the approximate configuration as shown in Figure 1. Native materials would be used to construct the berms which would be about 4 feet high with a crest width of 6 feet. Some sand and gravel may be imported to provide a minimum percolation depth of 3 feet. Percolation of 6 MGD continuously would require wetting 85 acres. This 85 acres would be sufficiently large to accommodate the average flow as well as a peak flow 20 percent greater than the average flow.

Operational Characteristics

The infiltration ponds would be operated year round. To maintain good infiltration characteristics, the cells would need to be cycled such that they are wet for an equal period of dry time. Additionally, over a period of time the infiltration rate may diminish. Consequently, the basins will need to be disked or rototilled annually. It is also estimated that the berms may require major repair at 10-year intervals.

Other maintenance that would be required includes periodic cleaning of the transmission pipe and repair of roads and fences.

Hydrologic Disposal Characteristics

Percolation and soils data were gathered by a representative of Cooper-Clark and Associates of Palo Alto, California. The data were gathered on July 17, 18 and 19, 1979 and a report was prepared discussing the results and implications of the data gathered.

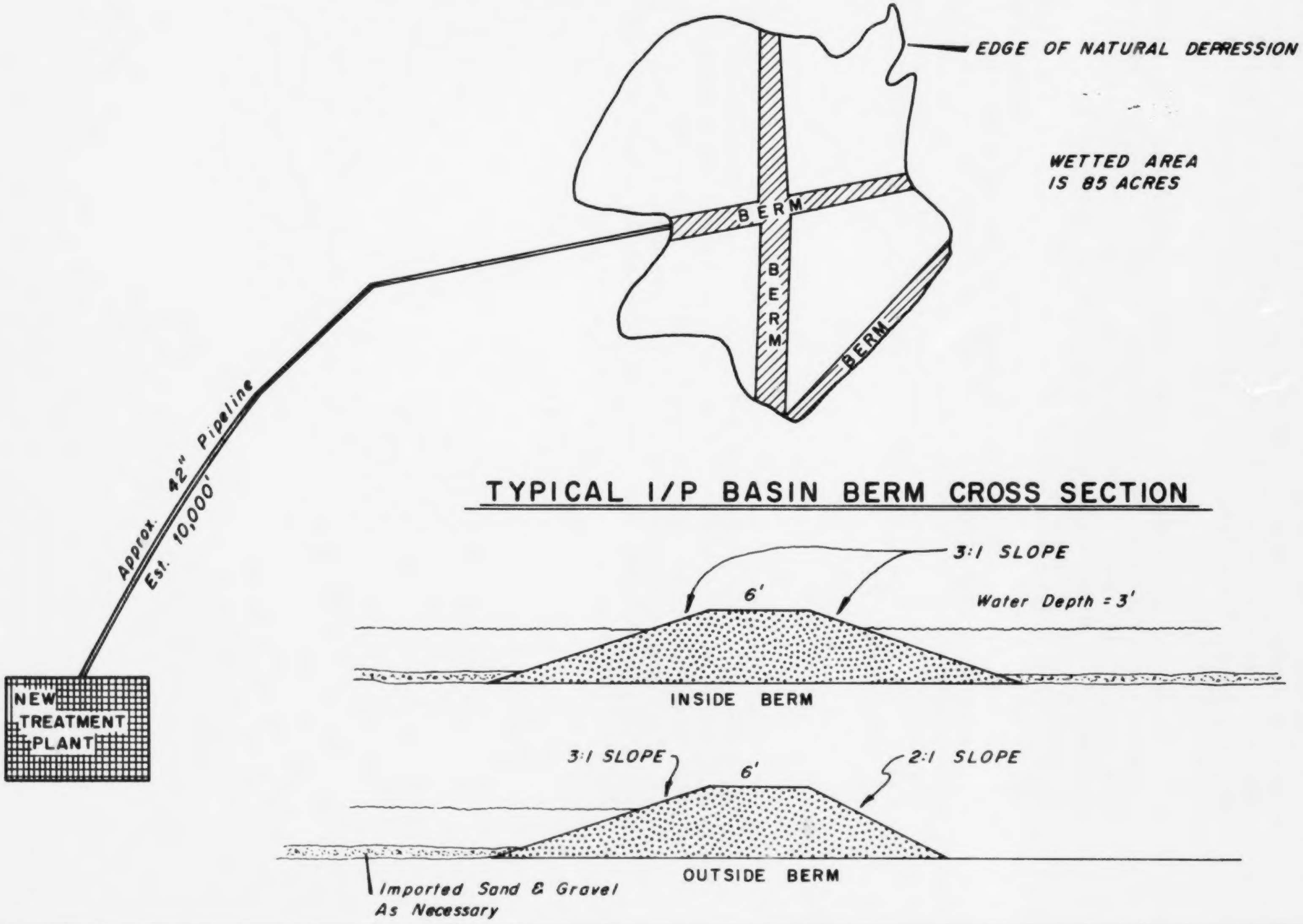
Based on preliminary data, the clear water infiltration rate was measured to be an average of 7/8 inch per hour or 147 inches per week. However, use of wastewater substantially reduces the amount of water that can be percolated. For purposes of this study, a rate of 15 percent of the clear water rate or 22 inches per week was used to determine the land area required. A value of 5-25 percent of the clear water rate is recommended by EPA. Local evaporation records were used to determine the amount of evaporation that might be experienced. The evaporation rate was found to be negligible compared to the percolation rate. Allowing for peak flows and reduced infiltration capacity, about 85 acres will be needed to dispose of the wastewater.

Treatment Reliability

The treatment reliability would be improved over secondary treatment. The soils would remove a great proportion of any suspended solids remaining after secondary sedimentation. The design should include assurance of a minimum of 3 feet of percolation media. It has been demonstrated that 3 feet of media is capable of reducing pathogenic organisms that may be remaining.

FIGURE 1

SCHEMATIC DIAGRAM OF INFILTRATION POND ALTERNATIVE


EDGE OF NATURAL DEPRESSION
WETTED AREA IS 85 ACRES
BERM
BERM
BERM
Approx. 42" Pipeline
Est. 10,000'
NEW TREATMENT PLANT
TYPICAL I/P BASIN BERM CROSS SECTION
3:1 SLOPE
6'
Water Depth = 3'
INSIDE BERM
3:1 SLOPE
6'
2:1 SLOPE
OUTSIDE BERM
Imported Sand & Gravel As Necessary

Appendix 2

EFFLUENT DISPOSAL VIA EVAPOTRANSPIRATION PONDS

Culp, Wesner and Culp
July 1979

Physical Facilities

This alternative proposes to dispose of treated wastewater by discharging to a series of artificial wetland ponds or marshes. To supplement the ponds, infiltration basins would be provided to dispose of the treated effluent during peak flow periods and for winter flows. Since the wetlands would be primarily used to dispose of the water, the ponds would need to be designed as evaporation ponds with sufficient capacity for water storage. The basins would be sized to evaporate about 3 feet of water per year during the months of April through October. This would dispose of about 60 percent of the annual wastewater flow. The balance of the flow would be placed in infiltration basins designed the same as the basins for subsurface disposal via infiltration basins.

As seen in Figure 1, the marshes would be aligned in series with the infiltration basin in parallel. Flow to the first marshes and the infiltration basin would require gravity flow through a pipeline. Subsequent downstream flow would utilize lined trapezoidal canals. Natural depressions would be utilized as much as possible for embankments. Artificial embankments, or berms, would be constructed the same as for infiltration basins. The marshes would have an average depth of 9 feet and would be lined with bentonite to minimize water loss through the bottom. The marshes would be stocked with marsh plants native to the Bend area. Fish would be stocked in the ponds to reduce the potential mosquito population.

Operational Characteristics

The proposed system could be operated year round. The marshes would be fed water from April through October, while the infiltration basins would receive peak flows and winter flows. The infiltration basins would be operated in the same manner as for subsurface disposal via infiltration basins.

The marsh ponds would require a minimum of maintenance. Periodically, the plants growing in the marshes would need to be harvested. The resulting plant debris could either be disposed in a landfill, composted to be used as a soil amendment, or processed as cattle feed.

Limitations experienced with wetlands include poor plant growth during winter, loss of duckweed from blowing winds, and mosquito growth. All can be controlled by proper marsh management. The most significant limitation with the wetlands as proposed is the salt buildup in the residual water as the evaporation occurs.

Hydrologic Disposal Characteristics

Design of the wetlands is essentially the same as a design for evaporation ponds. It is estimated that the wetlands would experience about 3 feet of evaporation during the application periods. Thus, maximizing the evaporation, the wetlands would require 1,270 acres.

The ponds could dispose of about 3,940 acre-feet of wastewater during the year. The balance (2,780 acre-feet) would be discharged to the infiltration basins. It is estimated that the infiltration basins will require 35 acres.

Treatment Reliability

Wetlands can produce a higher quality effluent. Test units operating artificial marsh facilities have reported significant reductions in BOD, suspended solids, ammonia, nitrate, phosphorus and coliform organisms. The quality of water produced from wetlands treatment has been considered to be much higher quality than secondary effluent.

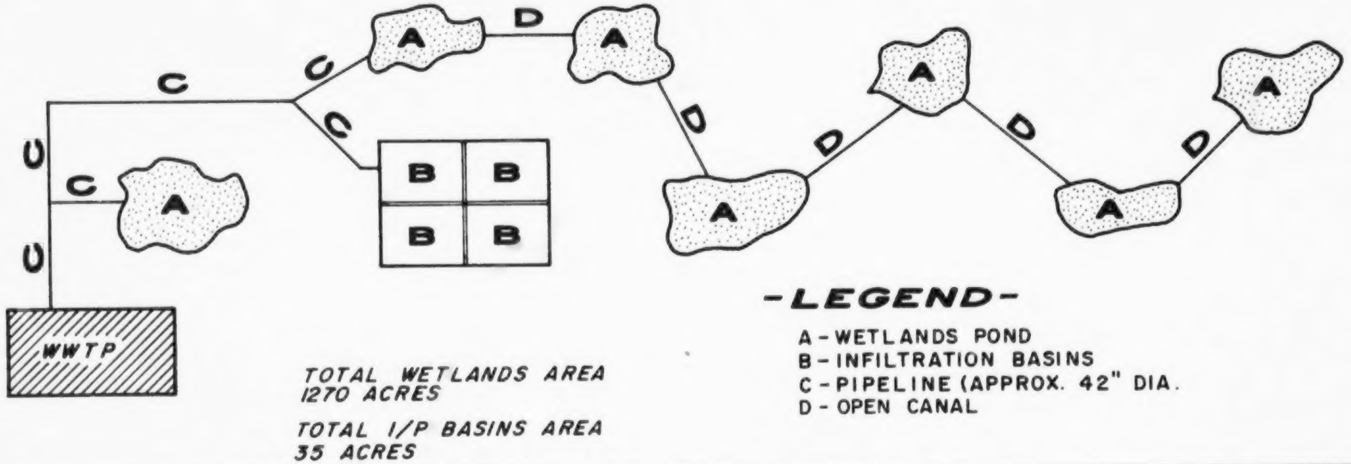
Treatment using marshlands has some limitations. Salt accumulation and low temperatures could hamper plant growth, thus reducing nutrient removal.

Modifications for Cost Reduction

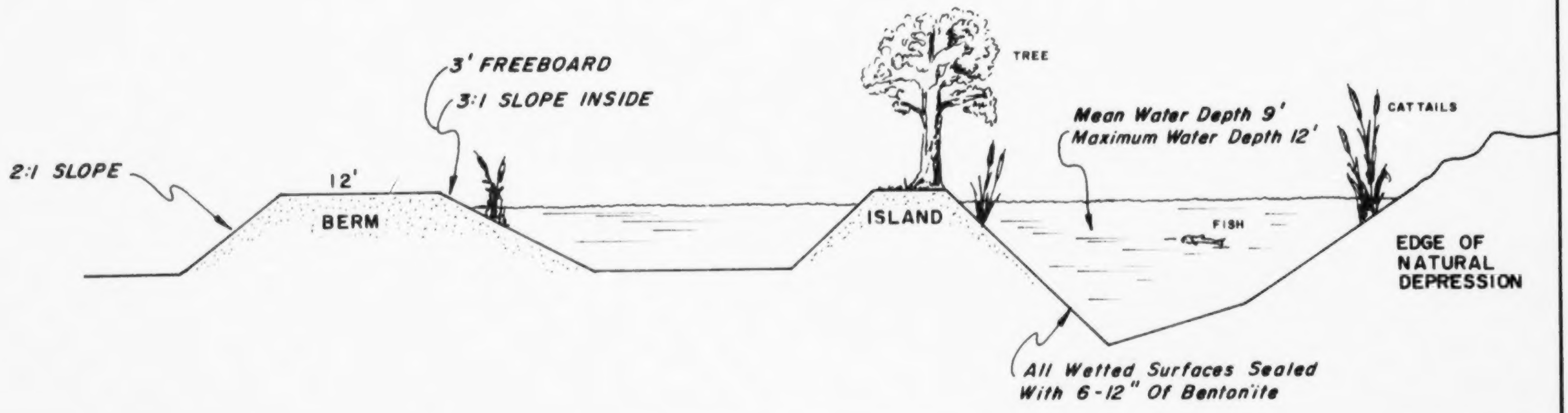
Substantial cost savings could be realized by using the wetlands as a treatment process rather than a disposal method. If this were done, any number of acres could be used but optimum treatment could be achieved using 150 acres. Another method of reducing the cost could be realized by using the downstream ponds as percolation basins. Regardless of which method is chosen, staging the construction as capacity is needed could reduce the immediate cost.

FIGURE 1

SCHEMATIC DIAGRAM OF THE EVAPOTRANSPIRATION POND ALTERNATIVE


WWTP
A
B
C
D
TOTAL WETLANDS AREA
1270 ACRES
TOTAL I/P BASINS AREA
35 ACRES
-LEGEND-
A - WETLANDS POND
B - INFILTRATION BASINS
C - PIPELINE (APPROX. 42" DIA.
D - OPEN CANAL

TYPICAL WETLANDS CROSS SECTION


2:1 SLOPE
12'
BERM
3' FREEBOARD
3:1 SLOPE INSIDE
TREE
ISLAND
Mean Water Depth 9'
Maximum Water Depth 12'
FISH
CATTAILS
EDGE OF
NATURAL
DEPRESSION
All Wetted Surfaces Sealed
With 6-12" Of Bentonite

NATIONAL INTERIM PRIMARY DRINKING WATER REGULATIONS - MAXIMUM CONTAMINANT LEVELS

(Federal Register 40(248), 1975 and 41(133), 1976)

Subpart B—Maximum Contaminant Levels

§ 141.11 Maximum contaminant levels for inorganic chemicals.

(a) The maximum contaminant level for nitrate is applicable to both community water systems and non-community water systems. The levels for the other inorganic chemicals apply only to community water systems. Compliance with maximum contaminant levels for inorganic chemicals is calculated pursuant to § 141.23.

(b) The following are the maximum contaminant levels for inorganic chemicals other than fluoride:

Contaminant	*Level, milligrams per liter*
Arsenic	0.05
Barium	1.
Cadmium	0.010
Chromium	0.05
Lead	0.05
Mercury	0.002
Nitrate (as N)	10.
Selenium	0.01
Silver	0.05

(c) When the annual average of the maximum daily air temperatures for the location in which the community water system is situated is the following, the maximum contaminant levels for fluoride are:

Temperature Degrees Fahrenheit	Degrees Celsius	Level, milligrams per liter
53.7 and below	12.0 and below	2.4
53.8 to 58.3	12.1 to 14.6	2.2
58.4 to 63.8	14.7 to 17.6	2.0
63.9 to 70.6	17.7 to 21.4	1.8
70.7 to 79.2	21.5 to 26.2	1.6
79.3 to 90.5	26.3 to 32.5	1.4

§ 141.12 Maximum contaminant levels for organic chemicals.

The following are the maximum contaminant levels for organic chemicals. They apply only to community water systems. Compliance with maximum contaminant levels for organic chemicals is calculated pursuant to § 141.24.

	Level, milligrams per liter
(a) Chlorinated hydrocarbons:	
Endrin (1,2,3,4,10, 10-hexachloro-6,7-epoxy-1,4, 4a,5,6,7,8,8a-octahydro-1,4-endo, endo-5,8 - dimethano naphthalene).	0.0002
Lindane (1,2,3,4,5,6-hexachlorocyclohexane, gamma isomer).	0.004
Methoxychlor (1,1,1-Trichloro-2, 2 - bis [p-methoxyphenyl] ethane).	0.1
Toxaphene ($C_{10}H_{10}Cl_8$-Technical chlorinated camphene, 67–69 percent chlorine).	0.005
(b) Chlorophenoxys:	
2,4 - D, (2,4-Dichlorophenoxyacetic acid).	0.1
2,4,5-TP Silvex (2,4,5-Trichlorophenoxypropionic acid).	0.01

§ 141.13 Maximum contaminant levels for turbidity.

The maximum contaminant levels for turbidity are applicable to both community water systems and non-community water systems using surface water sources in whole or in part. The maximum contaminant levels for turbidity in drinking water, measured at a representative entry point(s) to the distribution system, are:

(a) One turbidity unit (TU), as determined by a monthly average pursuant to § 141.22, except that five or fewer turbidity units may be allowed if the supplier of water can demonstrate to the State that the higher turbidity does not do any of the following:

(1) Interfere with disinfection;

(2) Prevent maintenance of an effective disinfectant agent throughout the distribution system; or

(3) Interfere with microbiological determinations.

(b) Five turbidity units based on an average for two consecutive days pursuant to § 141.22.

§ 141.14 Maximum microbiological contaminant levels.

The maximum contaminant levels for coliform bacteria, applicable to community water systems and non-community water systems, are as follows:

(a) When the membrane filter technique pursuant to § 141.21(a) is used, the number of coliform bacteria shall not exceed any of the following:

(1) One per 100 milliliters as the arithmetic mean of all samples examined per month pursuant to § 141.21 (b) or (c);

(2) Four per 100 milliliters in more than one sample when less than 20 are examined per month; or

(3) Four per 100 milliliters in more than five percent of the samples when 20 or more are examined per month.

(b)(1) When the fermentation tube method and 10 milliliter standard portions pursuant to § 141.21(a) are used, coliform bacteria shall not be present in any of the following:

(i) more than 10 percent of the portions in any month pursuant to § 141.21 (b) or (c);

(ii) three or more portions in more than one sample when less than 20 samples are examined per month; or

(iii) three or more portions in more than five percent of the samples when 20 or more samples are examined per month.

(2) When the fermentation tube method and 100 milliliter standard portions pursuant to § 141.21(a) are used, coliform bacteria shall not be present in any of the following:

(i) more than 60 percent of the portions in any month pursuant to § 141.21 (b) or (c);

(ii) five portions in more than one sample when less than five samples are examined per month; or

(iii) five portions in more than 20 percent of the samples when five or more samples are examined per month.

(c) For community or non-community systems that are required to sample at a rate of less than 4 per month, compliance with paragraphs (a), (b)(1), or (b)(2) of this section shall be based upon sampling during a 3 month period, except that, at the discretion of the State, compliance may be based upon sampling during a one-month period.

§ 141.15 Maximum contaminant levels for radium-226, radium-228, and gross alpha particle radioactivity in community water systems.

The following are the maximum contaminant levels for radium-226, radium-228, and gross alpha particle radioactivity:

(a) Combined radium-226 and radium-228—5 pCi/1.

(b) Gross alpha particle activity (including radium-226 but excluding radon and uranium)—15 pCi/1.

§ 141.16 Maximum contaminant levels for beta particle and photon radioactivity from man-made radionuclides in community water systems.

(a) The average annual concentration of beta particle and photon radioactivity from man-made radionuclides in drinking water shall not produce an annual dose equivalent to the total body or any internal organ greater than 4 millirem/year.

(b) Except for the radionuclides listed in Table A, the concentration of man-made radionuclides causing 4 mrem total body or organ dose equivalents shall be calculated on the basis of a 2 liter per day drinking water intake using the 168 hour data listed in "*Maximum Permissible Body Burdens and Maximum Permissible Concentration of Radionuclides in Air or Water for Occupational Exposure*," NBS Handbook 69 as amended August 1963, U.S. Department of Commerce. If two or more radionuclides are present, the sum of their annual dose equivalent to the total body or to any organ shall not exceed 4 millirem/year.

TABLE A.—*Average annual concentrations assumed to produce a total body or organ dose of 4 mrem/yr*

Radionuclide	Critical organ	pCi per liter
Tritium	Total body	20,000
Strontium-90	Bone marrow	8

Subpart C—Monitoring and Analytical Requirements

§ 141.21 Microbiological contaminant sampling and analytical requirements.

(a) Suppliers of water for community water systems and non-community water systems shall analyze for coliform bacteria for the purpose of determining compliance with § 141.14. Analyses shall be conducted in accordance with the analytical recommendations set forth in "Standard Methods for the Examination of Water and Wastewater," American Public Health Association, 13th Edition, pp. 662–688, except that a standard sample size shall be employed. The standard sample used in the membrane filter procedure shall be 100 milliliters.

Appendix 4

OREGON STATE HEALTH DIVISION WATER QUALITY STANDARDS - OREGON ADMINISTRATIVE RULE 333-42-210

Water Quality Standards

333-42-210 (1) Scope: The water quality standards apply to water leaving the source facilities and to water entering the user's service pipeline.

(2) Chemical Quality:

(a) Routine Analysis:

Contaminant	Max. Allowable Concentration in mg/1
Alkalinity (Total as $CaCO_3$)	N.A.
Calcium	N.A.
Chloride	250.0
Copper	1.0
Fluoride	2.0
Hardness (as Ca CO_3)	N.A.
Iron	0.30
Manganese	0.050
Magnesium	N.A.
Nitrate (as N)	10.0
Nitrite (as N)	N.A.
pH	N.A.
Silica	N.A.
Sodium	N.A.
Sulfate	250.0
Solids (Total)	1000.0
Solids (Volatile)	N.A.
Zinc	5.0

"N.A." means "not applicable" as applies to a maximum concentration but the determination shall be included in the analysis.

(b) Special Analysis:

When any of the following contaminants are suspected or known to be present in a concentration of 50% or more of the following limits, the analysis for the questioned contaminant shall be performed along with the routine chemical analysis:

Contaminant	Max. Allowable Concentration in mg/1
Arsenic	0.050
Barium	1.0
Cadmium	0.010
Chromium	0.050
Cyanide	0.20
Lead	0 050
Mercury	0.0020
Organics:	
Alkyl Benzene Sulfonate (ABS)	0.50
Carbon Chloroform Extract (CCE)	0.20
Phenols	0.0010
Selenium	0.010
Silver	0.050

(c) Miscellaneous: If there is reason to believe that the water contains any chemicals of known deleterious physiological effects or nuisance properties, then additional tests shall be conducted for these chemicals. If the Division finds such chemicals in excessive concentrations, then the concentration shall be lowered to an acceptable level or a new, acceptable source shall be developed.

(d) Routine Chemical Sampling Frequency Requirements: The water purveyor shall have a sample of finished water collected and analysed for each source at such a time as to represent conditions of average water quality as follows:

(A) For a surface water, infiltration gallery or shallow well source, an initial analysis before July 1, 1978, and thereafter annually;

(B) For deep well, an initial analysis before July 1, 1979, and thereafter at three year intervals.

(e) The Division may require that additional chemical sampling and analysis be performed when it is known or suspected that substandard water quality has occurred in the water system. (When any chemical contaminant is exceeded refer to subsection (8) below.)

(3) Physical Quality:

(a) The maximum allowable contaminant level of turbidity is one formazin turbidity unit for filtered water supplies. Up to five units may be allowed on unfiltered supplies if the water purveyor can demonstrate to the Division that the higher turbidity level does not:

(A) Interfere with disinfection; and

(B) Prevent maintenance of an effective disinfectant agent throughout the distribution system; and

(C) Interfere with microbiological determinations.

(b) Sand shall not be present in amounts greater than 2.0 mg/1.

(c) Color shall not exceed 15 units.

(d) Odor shall not exceed the threshold odor number 3.

(e) The water purveyor shall have a daily sample of finished water collected and analysed for turbidity from each source where turbidity contamination may be present. Color and/or odor levels shall be determined monthly when either the color and/or odor is suspected or known to exceed 50% of the limits. If the water quality is variable, the sample shall be collected at the time of suspected lowest quality.

(f) In the event that analysis indicates that any physical quality limit has been exceeded, the sampling and analysis shall be repeated promptly. The results of the two measurements shall be averaged, and recorded.

(g) The Division may require that additional physical quality sampling and analysis be performed when it is known or suspected that substandard water quality has occurred in the distribution system. (When any physical quality contaminant is exceeded refer to subsection (8) below.)

(4) Microbiological Quality:

(a) Maximum Contaminant Levels:

(A) When the membrane filter technique is used (100 milliliter sample size), the total coliform densities shall not exceed one per 100 milliliters as the arithmetic mean of all samples examined per month; and either:

(i) four per 100 milliliters in more than one standard sample when less than 20 are examined per month; or

(ii) four per 100 milliliters in more than five percent of the standard samples when 20 or more are examined per month.

(B) When the multiple tube fermentation method (10 milliliter standard portions) is used, total coliform organisms shall not be present in more than 10 percent of the portions in any month; and not be present in either:

(i) three or more portions in more than one sample when less than 20 samples are examined per month; or

(ii) three or more portions in more than five percent of the samples if more samples are examined per month.

s
i

Appendix 5

CONSTRUCTION AND USE OF WASTE DISPOSAL WELLS - OREGON ADMINISTRATIVE RULES 340-44-005 TO 340-44-045

"Construction or use of Waste Disposal Wells Prohibited

340-44-015 (1) After the effective date of these regulations, no person shall construct or place in operation any waste disposal well for the disposal of sewage without first obtaining a permit for said construction or operation of the waste disposal well from an approved permit-issuing agency.

(2) After the effective date of these regulations, no person shall construct or place in operation any waste disposal well for the disposal of sewage from a system serving more than 25 families or 100 people or of wastes other than sewage without first obtaining a permit from the State Sanitary Authority [DEQ].

(3) After January 1, 1975, no person shall maintain or use any waste disposal well for the disposal of sewage or wastes without a currently valid permit from an approved permit issuing agency or the State Sanitary Authority [DEQ] which specifically authorizes said maintenance or use.

It is the intent of this sub-section to phase out, by January 1, 1975, the use of waste disposal wells except for those which are scheduled to be replaced by sewers in accordance with an approved plan and time-schedule, and those which are operated under specific permit from the State Sanitary Authority [DEQ] pursuant to section 340-44-045 of these regulations."

Statutory Authority:
Hist: Filed 5-15-69 as SA 41

"Waste Disposal Wells Prohibited Where Better Treatment or Protections is Available

340-44-030 Permits shall not be issued for construction, maintenance or use of waste disposal wells where any other treatment or disposal method which affords better protection of public health or water resources is reasonably available or possible."

Statutory Authority:
Hist: Filed 5-15-69 as SA 41

Appendix 5 con't.

"Abandonment and Plugging of Waste Disposal Wells

340-44-040 (1) A waste disposal well upon discontinuance of use or abandonment shall immediately be rendered completely inoperable by plugging and sealing the hole to prevent the well from being a channel allowing the vertical movement of water and a possible source of contamination of the ground water supply."

"Construction or Use of Waste Disposal Wells Prohibited After January 1, 1980

340-44-045 After January 1, 1980, it shall be unlawful for any person to construct, maintain or use waste disposal wells for disposal of sewage or wastes unless said wastes have been previously treated by methods approved by the Sanitary Authority [DEQ] and further such treated wastes shall be discharged to waste disposal wells only if specifically approved and authorized by the Sanitary Authority [DEQ].

It is intended that this section will permit consideration for approval by the Sanitary Authority [DEQ] of waste disposal to deep injection wells, constructed and operated in accordance with a carefully engineered program, and for disposal to waste disposal wells of adequately treated and disinfected effluents from large, efficiently-operated, municipal or county sewage treatment plants where continuous and effective surveillance and control of waste treatment and discharge can be assured so as to fully safeguard water quality and the public health and welfare."

Statutory Authority:
Hist: Filed 5-15-69 as SA 41

Appendix 6

WATER QUALITY STANDARDS AND MINIMUM DESIGN CRITERIA - DESCHUTES RIVER BASIN - OREGON REVISED STATUTES

"Water Quality Standards Not to be Exceeded (to be adopted pursuant to ORS 468.735 and enforceable pursuant to ORS 468.720, 468.990, and 468.992.)

340-41-565 (1) Notwithstanding the water quality standards contained below, the highest and best practicable treatment and/or control of wastes, activities, and flows shall in every case be provided so as to maintain dissolved oxygen and overall water quality at the highest possible levels and water temperatures, coliform bacteria concentrations, dissolved chemical substances, toxic materials, radioactivity, turbidities, color, odor, and other deleterious factors at the lowest possible levels.

(2) No wastes shall be discharged and no activities shall be conducted which either alone or in combination with other wastes or activities will cause violation of the following standards in the waters of the Deschutes River Basin:"

1. Dissolved Oxygen: "DO concentrations shall not be less than 90 percent of saturation at the seasonal low, or less than 95 percent of saturation in spawning areas during spawning, incubation, hatching, and fry stages of salmonid fishes."

2. Temperature: "No measurable increases shall be allowed when stream temperatues are 58°F or greater; or more than 0.5°F. increase due to a single-source discharge when receiving water temperatures are 57.5°F. or less or more than 2°F. increase due to all sources combined when stream temperatures are 56°F. or less, except for specifically limited duration activities which may be specifically authorized by DEQ under such conditions as it may prescribe and which are necessary to accommodate legitimate uses or activities where temperatures in excess of this standard are unavoidable."

3. Turbidity: " (Jackson Turbidity Units, JTU): No more than 10 percent cumulative increase in natural stream turbidities shall be allowed except for certain specifically limited duration activities which may be specifically authorized by DEQ under such conditions as it may prescribe and which are necessary to accommodate essential drudging, (sic), construction, or other legitimate uses or activities where turbidities in excess of this standard are unavoidable."

4. pH: 6.5 - 8.5

Appendix 6 con't.

5. Coliform Bacteria: "Average concentrations of coliform organisms shall not exceed 240 per 100 milliliters, except during periods of high natural surface runoff."

"Bacterial pollution or other conditions deleterious to waters used for domestic purposes, livestock watering, irrigation, bathing, or shellfish propagation, or otherwise injurious to public health shall not be allowed.

The liberation of dissolved gases, such as carbon-dioxide, hydrogen sulfide, or other gases, in sufficient quantities to cause objectionable odors or to be deleterious to fish or other aquatic life, navigation, recreation, or other reasonable uses made of such waters shall not be allowed.

The development of fungi or other growths having a deleterious effect on stream bottoms, fish or other aquatic life, or which are injurious to health, recreation, or industry shall not be allowed.

The creation of tastes or odors or toxic or other conditions that are deleterious to fish or other aquatic life or affect the potability of drinking water or the palatability of fish or shellfish shall not be allowed.

The formation of appreciable bottom or sludge deposits or the formation of any organic or inorganic deposits deleterious to fish or other aquatic life or injurious to public health, recreation or industry shall not be allowed.

Objectionable discoloration, scum, oily sleek or floating solids, or coating of aquatic life with oil films shall not be allowed.

Aesthetic conditions offensive to the human senses of sight, taste, smell, or touch shall not be allowed.

Radioisotope concentrations shall not exceed Maximum Permissible Concentrations (MPC's) in drinking water, edible fishes or shellfishes, wildlife, irrigated crops, livestock and dairy products, or pose an external radiation hazard.

The concentration of total dissolved gas relative to atmospheric pressure at the point of sample collection shall not exceed one hundred and five percent (105%) of saturation, except when stream flow exceeds the 10-year, 7-day average flood.

Dissolved Chemical Substances: Guide concentrations listed below shall not be exceeded unless otherwise specifically authorized by DEQ upon such conditions as it may deem necessary to carry out the general intent of this plan and to protect the beneficial uses set forth in section 340-41-562:

	mg/l
Arsenic (As)	0.01
Barium (Ba)	1.0
Boron (Bo)	0.5
Cadmium (Cd)	0.003
Chromium (Cr)	0.02
Copper (Cu)	0.005

Appendix 6 con't.

Cyanide (Cn)	0.005
Fluoride (F)	1.0
Iron (Fe)	0.1
Lead (Pb)	0.05
Manganese (Mn)	0.05
Phenols (totals)	0.001
Total dissolved solids	500.0
Zinc (Zn)	0.01"

Minimum Design Criteria for Treatment and Control of Wastes (340-41-575 in part)

"During periods of low stream flows (approximately April 1 to October 31): Treatment resulting in monthly average effluent concentrations not to exceed 10 mg/l of BOD and 10 mg/l of SS or equivalent control.

During the period of high stream flows (approximately November 1 to March 31): A minimum of secondary treatment or equivalent and unless otherwise specifically authorized by the Department, operation of all waste treatment and control facilities at maximum practicable efficiency and effectiveness so as to minimize waste discharges to public waters.

Effluent BOD concentrations in mg/l, divided by the dilution factor (ratio of receiving stream flow to effluent flows) shall not exceed one (1) unless otherwise approved by the EQC.

Sewage wastes shall be disinfected, after treatment, equivalent to thorough mixing with sufficient chlorine to provide a residual of at least 1 part per million after 60 minutes of contact time unless otherwise specifically authorized by permit.

Positive protection shall be provided to prevent bypassing raw or inadequately treated sewage to public waters unless otherwise approved by the Department where elimination of inflow and infiltration would be necessary but not presently practicable.

More stringent waste treatment and control requirements may be imposed where special conditions may require."

Appendix 7

STATE OF OREGON
ROBERT W. STRAUB
GOVERNOR

Department of Environmental Quality

522 SOUTHWEST 5TH AVE. PORTLAND, OREGON

MAILING ADDRESS: P.O. BOX 1760, PORTLAND, OREGON 97207

March 14, 1978

North Unit Irrigation District
Route 2, Box 1224
Madras, OR 97741

Attention: Mr. Roger S. Norland, Secretary-Manager

Re: NPDES Permit Revocation

Gentlemen:

As you are probably aware, the Clean Water Act of 1977 made several significant changes in the Federal Water Pollution Control Act. One of the changes made was to remove irrigation return flow from the point source category and identify it as a non-point source. This means that an NPDES permit is no longer required for irrigation return flows.

Since your NPDES permit No. 1672J is no longer legally required, I hereby revoke it. If you object to this revocation please notify me within 20 days.

Since irrigation return flows are to be controlled by best management practices in accordance with a statewide management plan (208) I trust you will continue to be environmentally conscious and do all you can to help the 208 planning process develop a workable plan. If you have any questions about progress being made in that area please contact Mr. Neil Mullane of this office at 229-6065.

Thank you for your cooperation.

Sincerely,

WILLIAM H. YOUNG
Director

CKA:aes

Reproduced from best available copy.

Appendix 8

Department of Environmental Quality
CENTRAL REGION
2150 N.E. STUDIO ROAD, BEND, OREGON 97701 PHONE (503) 382-6446

February 8, 1979

Bend Engineering Consultants
Bend, OR 97701

S - Bend Phase I
Deschutes County

Attn: Mr. Pat Case

Gentlemen:

For discharge to the North Unit Irrigation District Canal or to a disposal well, the Department believes the new City of Bend sewage treatment plant should, on an interim basis, treat to a 20-20 level, i.e. 20 mg/l BOD-5 and 20 mg/l total suspended solids. The plant should be designed for ultimate addition of necessary equipment to treat to a 10-10 level. Disinfection shall be provided to achieve a fecal coliform level less than 10 per 100 mls.

We believe these treatment standards will adequately protect the beneficial uses of either receiving body.

Should the city desire to discharge to the irrigation canal, written permission must be granted by the irrigation district. Discharge to a disposal well must be in accordance with the provisions of OAR 340-44-045.

Hopefully, this answers your questions.

Sincerely,

Richard J. Nichols

Richard J. Nichols
Regional Manager

RJN:dmc

cc:City of Bend
:Water Quality Division

Contains Recycled Materials

Appendix 9

CURRENT WATER POLLUTION CONTROL FACILITIES PERMIT - CITY OF BEND

DEPARTMENT OF ENVIRONMENTAL QUALITY
1234 S. W. Morrison Street
Portland, Oregon 97205
Telephone: (503) 229-5696

Permit Number: 2610
Expiration Date: 6-30-82
File Number: 7517
Page 1 of 7

WATER POLLUTION CONTROL FACILITIES PERMIT

Issued pursuant to ORS 468.740

ISSUED TO:

City of Bend
P. O. Box 431
Bend, Oregon 97701

PLANT TYPE AND LOCATION:

Activated sludge
East of Pilot Butte

Issued in response to application number 2158 received 3-10-77.

William H. Young
William H. Young
Director

AUG 10 1977
Date

SOURCES COVERED BY THIS PERMIT:

Type of Waste	Method of Disposal
Domestic	Lava sink hole and land

RIVER BASIN INFORMATION

Major Basin: Deschutes
Minor Basin:
County: Deschutes

Nearest surface stream which could be influenced by waste disposal system: Deschutes River

PERMITTED ACTIVITIES

Until this permit expires or is modified or revoked, the permittee is authorized to construct, install, modify or operate waste water treatment, control and disposal facilities in conformance with requirements, limitations and conditions set forth in attached schedules as follows:

Page
Schedule A - Waste Disposal Limitations 2
Schedule B - Minimum Monitoring and Reporting Requirements 3
Schedule C - Compliance Conditions and Schedules 4
Schedule D - Special Conditions 5
General Conditions 6-7

All direct discharges to public waters are prohibited.

This permit does not relieve the permittee from responsibility for compliance with other applicable Federal, state or local laws, rules or standards.

State of Oregon
Department of Environmental Quality
PERMIT CONDITIONS

Permit Number: 2610
Expiration Date: 6-30-82
Page 2 of 7

City of Bend

SCHEDULE A

Waste Disposal Limitations

1. No discharge to state waters is permitted. All waste waters shall be discharged to the sink hole or distributed on land for dissipation by evapo-transpiration and controlled seepage by following sound irrigation practices so as to prevent:

   a. Prolonged ponding of waste on the ground surface;

   b. Surface runoff or subsurface drainage through drainage tile;

   c. The creation of odors, fly and mosquito breeding and other nuisance conditions; and

   d. The overloading of land with nutrients or organics.

2. The permittee shall, during all times of disposal, provide personnel whose primary responsibilities are to assure the continuous performance of the disposal system within the limitations of this permit.

3. Prior to disposal of the waste water it shall receive at least the following treatment:

   a. Monthly average effluent flow shall not exceed 3785 m^3/d (1.0 MGD).

   b. BOD and TSS shall not exceed a monthly average of 20 mg/l or 76 kg/day (166.8 lb/day); weekly average of 30 mg/l or 113 kg/day (250 lb/day); and a daily maximum of 170 kg (375 lb).

   c. Effluent discharged to the sink hole shall receive disinfection sufficient to reduce fecal coliform bacteria to a monthly average of 200 per 100 ml or a weekly average of no more than 400 per 100 ml.

   d. Effluent disposed of on land shall receive disinfection sufficient to reduce fecal coliform bacteria to a monthly average of no more than 20 per 100 ml. In no case shall the chlorine residual be permitted to drop below 1.0 mg/l.

   e. The effluent pH shall be within the range 6.0 - 9.0.

4. Unless approved otherwise in writing by the Department, a deep-rooted, permanent grass cover shall be maintained on the land disposal area at all times and periodically cut to maintain it in the growth cycle to insure maximum infiltration and evapo-transpiration rate during the disposal season.

State of Oregon
Department of Environmental Quality
P E R M I T   C O N D I T I O N S

Permit Number: 2610
Expiration Date: 6-30-82
Page 3 **of** 7

City of Bend

SCHEDULE B

Minimum Monitoring and Reporting Requirements

The permittee shall monitor the operation and efficiency of all treatment and disposal facilities. Unless otherwise agreed to in writing by the Department of Environmental Quality, data collected and submitted shall include but not necessarily be limited to the following parameters and minimum frequencies:

Item or Parameter	Minimum Frequency	Type of Sample
Total Flow	Daily	--
Pounds Chlorine Used	Daily	--
Chlorine Residual (effluent)	Daily	Grab
BOD (influent & effluent)	2 per week	Composite
Suspended Solids (influent & effluent)	2 per week	Composite
pH (influent & effluent)	3 per week	Grab
Sludge Settleability Test	3 per week	Grab
Fecal Coliform	Quarterly Monthly when irrigating	Grab

Monthly reports shall also include a record of the location and method of disposal of all sludge and a record of all equipment breakdowns and bypassing.

Reporting Procedures

Monitoring results shall be reported on approved forms. The reporting period is the calendar month. Reports must be submitted to the Department by the 15th day of the following month.

State of Oregon
Department of Environmental Quality
PERMIT CONDITIONS

Permit Number: 2610
Expiration Date: 6-30-82
Page 4 of 7

City of Bend

SCHEDULE C

Compliance Conditions and Schedules

1. As soon as practicable, but not later than January 1, 1980, the permittee shall construct and place into operation sewage collection, treatment and disposal facilities adequate to serve the unsewered portions of the City. The permittee shall require all users of disposal wells in the City to abandon their wells in accordance with OAR 340-44-040 and connect to the Bend collection system.

2. It is the intent of Condition 1 above to help eliminate the use of sewage disposal wells in the Bend area. Disposal of waste treatment products from any new facility shall be done such that potential for contamination of ground or surface waters shall be minimized.

   Sewage treatment plant effluent disposal practices will be such that discharge of effluent to disposal wells shall be done only on an emergency basis and with specific approval from the Department of Environmental Quality.

State of Oregon
Department of Environmental Quality
PERMIT CONDITIONS

Permit Number: 2610
Expiration Date: 6-30-82
Page 5 **of** 7

City of Bend

SCHEDULE D

Special Conditions

1. Prior to constructing or modifying any waste water control facilities, detailed plans and specifications shall be approved in writing by the Department.

2. An adequate contingency plan for prevention and handling of spills and unplanned discharges shall be in force at all times. A continuing program of employee orientation and education shall be maintained to ensure awareness of the necessity of good inplant control and quick and proper action in the event of a spill or accident.

GENERAL CONDITIONS

G1. The permittee shall provide an adequate operating staff which is duly qualified to carry out the operation, maintenance and testing functions required to insure compliance with the conditions of this permit.

G2. All waste collection, control, treatment and disposal facilities shall be operated in a manner consistent with the following:

a. At all times all facilities shall be operated as efficiently as possible and in a manner which will prevent discharges, health hazards and nuisance conditions.

b. All screenings, grit and sludge shall be disposed of in a manner approved by the Department of Environmental Quality such that it does not reach any of the waters of the state or create a health hazard or nuisance condition.

c. Bypassing of untreated waste is generally prohibited. No bypassing shall occur without prior written permission from the Department except where unavoidable to prevent loss of life or severe property damage.

G3. Whenever a facility expansion, production increase or process modification is anticipated which will result in a change in the character of pollutants to be discharged or which will result in a discharge to public waters, a new application must be submitted together with the necessary reports, plans and specifications for the proposed changes. No change shall be made until plans have been approved and a new permit or permit modification has been issued.

G4. After notice and opportunity for a hearing this permit may be modified, suspended or revoked in whole or in part during its term for cause including but not limited to the following:

a. Violation of any terms or conditions of this permit or any applicable rule, standard, or order of the Commission;

b. Obtaining this permit by misrepresentation or failure to disclose fully all relevant facts.

G5. The permittee shall, at all reasonable times, allow authorized representatives of the Department of Environmental Quality:

a. To enter upon the permittee's premises where a waste source or disposal system is located or in which any records are required to be kept under the terms and conditions of this permit;

b. To have access to and copy any records required to be kept under the terms and conditions of this permit;

c. To inspect any monitoring equipment or monitoring method required by this permit; or

d. To sample any discharge of pollutants.

G6. The permittee shall at all times maintain in good working order and operate as efficiently as possible all treatment or control facilities or systems installed or used by the permittee to achieve compliance with the terms and conditions of this permit.

G7. The issuance of this permit does not convey any property rights in either real or personal property, or any exclusive privileges, nor does it authorize any injury to private property or any invasion of personal rights, nor any infringement of Federal, State or local laws or regulations.

G8. The Department of Environmental Quality, its officers, agents and employees shall not sustain any liability on account of the issuance of this permit or on account of the construction or maintenance of facilities because of this permit.

G9. In the event the permittee is unable to comply with all of the conditions of this permit because of a breakdown of equipment or facilities, an accident caused by human error or negligence, or any other cause such as an act of nature, the permittee shall:

a. Immediately take action to stop, contain and clean up the unauthorized discharges and correct the problem.

b. Immediately notify the Department of Environmental Quality so that an investigation can be made to evaluate the impact and the corrective actions taken and determine additional action that must be taken.

c. Submit a detailed written report describing the breakdown, the actual quantity and quality of resulting waste discharges, corrective action taken, steps taken to prevent a recurrence and any other pertinent information.

Compliance with these requirements does not relieve the permittee from responsibility to maintain continuous compliance with the conditions of this permit or the resulting liability for failure to comply.

G10. Definitions of terms and abbreviations used in this permit:

a. BOD means five-day biochemical oxygen demand.
b. TSS means total suspended solids.
c. mg/l means milligrams per liter.
d. kg means kilograms.
e. m^3/d means cubic meters per day.
f. MGD means million gallons per day.
g. Averages for BOD and TSS are based on arithmetic mean of samples taken.
h. Average coliform or fecal coliform is based on geometric mean of samples taken.
i. Composite sample means a combination of samples collected, generally at equal intervals over a 24-hour period, and apportioned according to the volume of flow at the time of sampling.
j. FC means fecal coliform bacteria.